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Do You Know . . . .

► . . . . That the weather for the Annual Meeting at Pittsburgh was wonderful? The traditional ASEE heat wave operated in reverse! Coats were almost mandatory and only a few traditionalists, including your Secretary and President, had the courage to appear once in a sport shirt. Other things were wonderful too—the "double" hospitality, the fine organization, etc. Several comments were received to the effect that one could sense the full support of the administration of the institutions involved. But read the Editor's story on page 15 for more details.

► . . . . That the 1360 paid registrations at the Annual Meeting set a new record? The total attendance of 2,202 is just short of the record. Apparently the metropolitan location offset the fine accommodations of Chatham College for children. There were 219 educational institutions from the United States represented, 121 professional and industrial organizations, 13 foreign universities, and 3 foreign industries or organizations. These attendance facts are gleaned from the roster always prepared by the McGraw-Hill Book Company and distributed at the Annual Banquet.

► . . . . That increasing the dues of individual members one dollar per year is just one step in the attempt to improve both the financial position and administration of the Society? The Financial Policy Committee and the Executive Board have long advocated an emergency reserve equal to three-quarters of a year's operating budget. This has never been achieved because the Executive Board has always believed that services to members should not be sacrificed merely to build up the reserve. A review of the functioning of Society Headquarters indicated that the amount of work has increased by leaps and bounds during the past four years and that all costs have increased. A 20% increase in membership is very good, but along with it comes a 20% increase in the processing of applications, maintenance of records, number of JOURNALS to be printed and mailed, size of the Yearbook, number of changes of addresses to be processed, etc., etc. In other words, the added income is not "all profit." The increased interest in engineering education on a nation-wide basis also means that the number of general inquiries for all kinds of information continues to mount. The increased activity of engineering faculties in research, public service, and consulting, and the tremendous increase in special studies, all mean that more people are knowing more about engineering education. In addition there is the growing realization of Sections, Divisions, etc. that they function as a part of the parent Society. In addition to increasing the dues of individual members one dollar per year, a request for almost $90,000 is being submitted to the National Science Foundation to aid the Society in overcoming its difficulties in the publication of the JOURNAL and the preparation of data for the Yearbook-Directory, an indirect cost charge of 5% of the total grant is to be incorporated in the negotiations for all future special studies, and a major effort is being made to increase the amount of advertising in the JOURNAL. This last effort involves the mailing of 2,700 letters! Nothing which has gone on during the past four and one-half years indicates that any policy other than one which will make ASEE *the* voice of engineering education is acceptable to the membership. With everyone's help this can be done, but it means *you* must aid in getting new members—individual, institutional, and industrial. It also means that you, by whatever means are at your disposal, must encourage advertising in the JOURNAL. These are the challenges facing all of us.

► . . . . That the *Proceedings* of the Society for 1958–59 were mailed on July 2? A communication from Lancaster Press states that they believe this is a new record for the Society, for they do not recall that the *Proceedings* had previously been mailed prior to August. The *Proceedings* are the bound volume of the papers published in the JOURNAL during a fiscal year and may be purchased by members for $7.00 per volume and by non-members for $9.00.

► . . . . That the report of the ASEE Engineering Education Exchange Mission to the Soviet Union printed in the May 1959 issue of the JOURNAL also is available as a separate report? Copies can be purchased from the Office of the Secretary for 25¢ each.

► . . . . That more nominations are needed for the four major awards of the Society? The Lamme, Westinghouse, Bendix, and McGraw Research awards are highly respected and there should be many candidates. It does take work to get material together for a nomination, but there are good men available and their names should be submitted for consideration. Information regarding awards is available from your Dean, from the Committee Chairmen, or from the Office of the Secretary. Pick your man and get busy.

► . . . . That suggestions for honorary membership may be made by any member of the Society to the Committee on Honorary Membership? G. W. Farnham is chairman of the committee and will be pleased to receive suggestions for consideration by the Committee. The Committee then selects two nominees and recommends them to the General Council for election. A favorable vote of at least three-fourths of the members of the General Council in a letter ballot is required for election.

► . . . . That "Research Relations Between Engineering Educational Institutional and Industrial Organizations," a report of ECRC under the direction of Dr. C. A. Dunn of the University of Oklahoma, has been published by the Small Business Administration as Small Business Management Series No. 23? The 38-page booklet can be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 25¢ each. In lots of 100 or more, mailed to a single address, a discount of 25% is offered.

► . . . . That for the first time in the history of the Society a railroad is an industrial member and that suddenly there are three? The Santa Fe was the first, and it was immediately followed by the CB & Q and the Illinois Central. This interest and support on behalf of the railroads is appreciated and is duly recognized and acknowledged. Divisions and Sections, in particular, should this year make a point of inviting representatives of the railroad industry to participate in their activities. To each of these member railroads we say, "Welcome, we admire your courage in breaking with tradition, and we hope your participation in the affairs of the Society will prove mutually beneficial."

► . . . . That "Humanities and Social Sciences" is the new name of the "Humanistic-Social Division"? The change was approved at the June meeting of the General Council.

► . . . . That the Executive Board authorized President B. R. Teare, Jr., to appoint new committees on Metallurgical Engineering and Ceramic Engineering? The action resulted from appropriate groups within AIME being interested in engineering education and requesting identification and recognition with ASEE in order to serve as organized groups for the continued study of educational problems in general as well as their own specific problems.

► . . . . That the summer school sponsored by the Engineering Economy Division was a tremendous success? About 125 attended, with about two-thirds from industry. Enthusiasm was so high that there were requests for holding an annual summer school. The Di

sion officers, however, declined because of the great amount of work involved. The papers presented are being assembled and will appear as a special issue of *The Engineering Economist*. It will need to be ordered separately from Professor Arthur Lesser, Stevens Institute of Technology, Hoboken, New Jersey.

► . . . . That a new Society called the American Society for Heating, Refrigerating, and Air-Conditioning Engineers is a consolidation of the American Society of Heating and Air-Conditioning Engineers and the American Society of Refrigerating Engineers? The consolidated Society has a membership of more than 18,000, the President is Cecil Boling of West Hartford, Conn., and A. V. Hutchinson is the Executive Secretary.

► . . . . That A. C. Blackman is the new managing director of the American Society for Safety Engineers? He formerly headed California's Division of Industrial Safety. ASSE has a worldwide membership of more than 7,000 safety engineers, "dedicated to upholding the standards of their profession and using their abilities for human service in the nation, state, and community."

► . . . . That a month before June graduation 83% of the estimated 39,000 engineering graduates had completed plans for post-graduation activities? About 63% had immediate employment, 11% were taking post-graduate work, 8% were going into military service, and an additional 12% were considering job offers or had other definite plans. By the third week in May less than 6% had no immediate plans for the future. The percentage being employed and the percentage pursuing graduate studies are greater than at a similar time for last year by 4.3% and 1.1%, respectively. These data are from the survey of the Engineering Manpower Commission, 29 West 39th Street, New York 18, New York. Copies of the complete report may be obtained from EMC without charge.

► . . . . That the 1959 edition of the Engineering Societies Directory is now available from EJC? It is the only comprehensive United States listing of engineering and scientific societies, their functional staff personnel, and publications. Societies and organizations, all state registration boards for professional licensing, National and International organizations and most Canadian engineering organizations are listed. Copies may be obtained from EJC, 29 West 39th Street, New York 18, New York, for $3.50 per copy.

► . . . . That a newsletter reporting on EJC activities, national affairs, and other administrative and legal events which affect the engineer now is being published by EJC and is named *Engineer*? The first issue is scheduled for September 1959. There will be nine issues a year. Distribution is free to responsible persons and organizations in industry, government, and education. Address EJC, 29 West 39th Street, New York 18, New York.

► . . . . That copies of "Salaries and Income of Engineering Teachers, 1958" can be purchased both from EJC and the office of the Secretary of the Society? This is a repeat of the survey made two years ago by the Committee on the Development of Engineering Faculties. The report is based on an analysis of 4,545 returns. The average professional income of engineering teachers in the United States rose from $8,862 in 1956 to $9,598 in 1958, an increase of 8.3%. The average teaching salary rose 13.5% during the same two-year period, but outside income dropped about 7%. In general, the teaching salaries increase with age, number of years of service, year since the first degree was earned, and the highest degree held. Please send 25¢ with the order.

► . . . . That "Scientists make it known, but engineers make it work!" is the theme of the series of public service advertisements EJC is inserting in *Editor and Publisher*? The ads are an attempt to create a desirable understanding of

engineers and engineering by printed media, radio, television, organizations, and advertising agencies. The first ad states what engineers do—apply the sciences to give people the use of nature's materials and forces; scientists make it known, engineers make it useful—they plan, design, produce, maintain and operate; scientists split the atom—engineers design and build the atomic power plants. Another is devoted to engineering shortage or over-supply, and specifically calls attention to the fact that the Engineering Manpower Commission always has the up-to-date facts. A third is devoted to, "Say engineer when you mean engineer!"

► . . . . That the papers presented at last summer's ASTM–ASEE Symposium on "Education in Materials" will be published by ASTM at the earliest possible moment? The cost has not yet been determined. Inquiries should be directed to ASTM at 1916 Race Street, Philadelphia 3, Pa.

► . . . . That an engineering education as "an excellent preparation for life" is a thought expressed by past President W. T. Alexander in his presidential address on page 10? Isn't this something that all of us should be recognizing and advocating? In this scientific age and in the years to come, engineering education should be regarded in the same category as liberal arts and as an attempt to get a sound general education enabling the individual to understand what is going on. And, also, should it not be as important for those in liberal arts to understand something of engineering as it is for the engineer to understand something of the liberal arts?

► . . . . That the 31 million dollars requested for loan funds for the 1959–60 academic year under the provisions of the National Defense Education Act are alloted to states on the basis of college enrollment, and then allocated to participating institutions within each state proportionately to the amount requested? Each institution uses its own judgment in estimating its needs and the extent of the amount it requests from the Office of Education. A twelve-member consultant panel of college administrators aids Commissioner of Education Lawrence G. Derthick in evaluating the requests.

► . . . . That the report "Providing U. S. Scientists with Soviet Scientific Information" is available on request from the Science Information Service of NSF? The survey reports on the sources of Soviet scientific literature, availability of such literature in the United States, and the current translation programs of professional and academic groups and government agencies. The Library of Congress also publishes a "Monthly Index of Russian Accessions," available from the Superintendent of Documents, Government Printing Office. The two main translation depositories in the United States are the Special Libraries Association Translation Center at the John Crerar Library in Chicago, collecting from non-Government sources, and the Office of Technical Services, Technical Information Division, Department of Commerce, collecting from Federal agencies and foreign sources. All translations are listed, with abstracts, in *Technical Translations*, published bimonthly since January of 1959 by the Department of Commerce. The report further states that previous concepts of centralization of information and abstracting services in Russia are somewhat in error because just like the actual research and primary publishing, the translating is by no means as highly centralized as many previous reports in this country have suggested.

► . . . . That "Teacher Supply and Demand in Universities, Colleges, and Junior Colleges, 1957–58 and 1958–59" is a new publication of the Research Division of the National Education Association? This biennial study of staff needs indicates that from 1953–54 through 1958–59 about 8.7% of new full-time teachers are in engineering; that for the same years about 14% of the new engineering teachers have a doctor's degree; that for the same years about 48% have less than the M.S. degree; that seven deanships are listed as unfilled in engi

neering; that 172 teaching positions in engineering are listed as unfilled; that 36 engineering schools foresee an acute shortage of qualified candidates; that for the 761 Ph.D.'s reported for engineering, 13.6% continued in college teaching, and of the 462 entering new occupations 14.6% entered college teaching; and that a total of 24,300 new full-time engineering teachers will be needed in 1959–70, inclusive, to aid the 17,500 now so engaged. Free copies (single) of Research Report 1959-R10 may be obtained from NEA Publication-Sales Section, 1201 16th Street, N.W., Washington 6, D. C.

► . . . . That the high school science and mathematics teacher situation is still bad but perhaps improving? The Engineering and Scientific Manpower Newsletter of June 30, 1959, states that in the class of 1959 there were 13.2% more prospective high school teachers than last year, but that only about 74% of the qualified graduates enter classroom teaching. The prospective number of new mathematics teachers is 4,723 as compared to 3,445 a year ago, and the number of prospective science teachers is 6,984 as compared to 5,467 a year ago. The sad part of the picture is indicated by a survey embracing thirty states and the District of Columbia and made in September 1958. It showed that of 2,637 new mathematics teachers employed, only 1,555 actually majored in mathematics. Some 576 more majored in general or physical science, but the remaining 506 posts were filled by majors in English, foreign language, home economics, industrial arts, music, physical education, and social studies. Only 170 of the 386 teachers hired to teach chemistry were majors in chemistry, and the score for physics teachers was 68 majors to fill 195 posts. Even if 100% of the mathematics and science teachers should decide to enter the classrooms, the needs of our high schools still would not be fully met. These data were obtained from the NEA Survey on "Teaching Supply and Demand in Public Schools."

W. Leighton Collins
Secretary

RESEARCH LAB RENOVATION SUPPORT FROM NSF

The National Science Foundation announces a new program for support of renovation and/or construction of graduate level (doctoral) research laboratories in the natural and engineering sciences at institutions of higher education. Generally speaking, equipment to be supported will be limited to standard fixed equipment (e.g., laboratory benches, built-in refrigerators, etc.), whether the grant is for construction of a new laboratory or the renovation of an existing one.

Proposals pertaining to laboratories for research use in any area of the basic sciences will be considered. However the Foundation will not consider requests for support of facilities to be used primarily for instructional purposes.

Grants made under this program will require matching by the institution, from non-Federal sources, to the extent of at least 50 per cent of the direct costs to be incurred. During fiscal year 1960 (July 1959 to June 1960), funds for this program will be severely limited in amount. Accordingly, it is expected that it will be possible to meet only the most urgent needs.

Proposals should be submitted to the National Science Foundation, Washington 25, D. C., by December 1, 1959. Address inquiry to the Division of Mathematical, Physical, and Engineering Sciences of the Foundation before preparing the proposal. It is anticipated that grants under this program will be made about June 1, 1960.

B. R. Teare, Jr.
President of ASEE for 1959–60

B. Richard Teare, Jr.
New President of ASEE

A President-elect of ASEE could have no more searching baptism of fire than having his college play host to an Annual Meeting. Dick Teare, Dean of Engineering and Science at Carnegie Institute of Technology and President of ASEE for 1959–1960 has experienced just such a prelude to the trials of office. Carnegie Tech was co-host with the University of Pittsburgh to the 1959 meeting of the Society.

B. Richard Teare, Jr., is a native of Wisconsin. He was educated at the University of Wisconsin, where he received the B.S. degree in 1927 and the M.S. degree in 1928. In the fall of 1929 he joined the General Electric Company at Schenectady as a student in the Advanced Course in Engineering and continued for four years with the educational program while he obtained practical experience in many departments, including Testing, Research, Alternating Current Engineering, Central Station Engineering, and General Engineering. In 1931 he became supervisor of the electrical engineering section of the Advanced Courses in which he had started as a student two years before.

After two more years at Schenectady, Dick Teare decided to enter the teaching field and accepted an instructorship in electrical engineering at Yale while he worked for his doctorate. He was made assistant professor in 1934 and received his Doctor of Engineering degree in 1936.

Dr. Teare left Yale to join the faculty of the Carnegie Institute of Technology in 1939, with responsibility for organizing a program of graduate study in electrical engineering. He was made Head of the Department of Electrical Engineering in 1944, Dean of Graduate Studies in 1950, and Dean of the College of Engineering and Science in 1952.

He has done research on hysteresis motors and copper covered steel conductors at high frequencies and has been active in a number of national projects in engineering education. He is a Fellow of the American Institute of Electrical Engineers and the Institute of Radio Engineers. In 1953–55 he was a vice president of ASEE and currently is vice president of AIEE for the Middle Eastern District.

The George Westinghouse Award was given Dean Teare in 1947 as recognition for his contributions to engineering education. Known for his pioneering work in the development and coordination of engineering courses, Dr. Teare is also a leader in the effort to design college programs which will give students competence in humanistic and social as well as technical fields.

At home Dick Teare likes to read, particularly detective stories. He is also a "do-it-yourselfer" who has demonstrated that he can descend from the theoretical heights of the engineering sciences to fix the plumbing, if need be. Such versatility is a valuable asset to the modern engineering educator.

Dean Teare came through the test of helping to host an Annual Meeting in good form that bodes well for the Society as it moves into the next challenging year under his leadership.

Engineering Education, Experience and Expectations

W. T. ALEXANDER

President of ASEE 1958–59; Dean of Engineering
Northeastern University, Boston

In this period of our history characterized by alarums and excursions, with a tense international situation, and many hopefuls in the political scene striving vocally to become leaders in one direction or another, I am tempted to use the time proven recipe and "point with pride" to the accomplishments of ASEE and to "view with alarm" the situation with regard to engineering education here and abroad; and there are grounds for this approach.

ASEE during the past year has had a gratifying growth in membership, both individual and industrial, and certainly has contributed to the progress of engineering education both directly and indirectly.

I could equally legitimately deprecate certain aspects of our system of education which have not in all respects reached the ideal. However, this approach would involve a considerable degree of abstraction and I have chosen instead to discuss certain aspects of the educational scene as I view it, wherein I feel that all of us as individuals may, if we wish, make some real and immediate contribution to the progress of engineering education.

The Individual Approach

This emphatically is a talk to you as individuals rather than as minute parts, numerically speaking, of the large corporate bodies which we speak of loosely as "industry" or as "education." I wish carefully to avoid in my remarks, and in your thinking, the use of these collective terms.

Presidential address delivered at the ASEE Annual Meeting in Pittsburgh, June, 1959.

When we glibly say that "industry" or "education" or "the government" should do this or that, there is a very comfortable degree of anonymity involved and too often it is the equivalent of saying, "Let George do it." This is an approach which none of us can afford longer to maintain. It is only when, as, and if each of us individually will assume responsibility for what we all agree should be accomplished, all too frequently by someone else, we feel, that we shall make the type of sound and rapid progress which is essential.

It is very tempting to think that we can cure any existing difficulty which plagues our society by passing a law, or appropriating a few millions of dollars, and then forgetting about the whole thing. Certainly additional amounts of money in considerable volume will be needed over the next few years by all levels of our educational system, but this alone will succeed only in perpetuating on a more luxurious level an over-all situation which we all recognize as somewhat less than satisfactory.

It is only through the efforts of all thoughtful people working as individuals in our own areas, as well as nationally through our Societies, that we can build up the true educational stature of our system and reshape the attitudes of those involved to the extent necessary to permit us to have continued prosperity, or possibly to permit us to survive as a democracy.

I believe it to be very important in our efforts toward improvement to consider our secondary, undergraduate, and graduate programs as a unit. Whether we like it or not, the quality of our graduates at any level is inseparably linked to the strength of each element in our educational chain, as well as to the closeness of

its co-ordination. This essential condition is very easy in an authoritarian state, but becomes much more difficult with our complex of public and private institutions at all three levels. Acceptance of this unitary concept will help to minimize the "buck passing" and "throwing of stones" too commonly observed between different segments of our system.

We must recognize that the quality of preparation in the secondary schools, generally speaking, will control the rate of progress of the undergraduate, and this in turn affects the maximum level of sophistication which can be reached in graduate school.

It is tempting to the colleges and graduate schools to consider setting individualistic and arbitrary standards, and this is clearly possible for certain privately endowed institutions. In some areas, however, it is not legally possible, and in any event it violates the principle of both quantity and quality simultaneously, which has long been a highly desirable and unique feature of the North American system of higher education.

Student Motivation

One of the great problems to which we must devote our best efforts, both individually and collectively, is that of improving the educational motivation of our young people. If we could overnight, by some miracle, instill in our young people a burning desire to learn and to become truly educated, most of our difficulties would automatically disappear. Unfortunately, not only is this the greatest asset which we could have in education in the U.S.A., but it is also the most difficult to attain. All of us must by precept and by example inculcate in our young people a respect and a desire for learning. No less important is the essential requirement that at both the national and local level we recognize and give at least as great status to intellectual achievements as to those in the area of physical sports.

While organizations and societies, and possibly governments, can give us aid in this essential activity, its real fundamental long-range and lasting effectuation must come from the home, for it is here that, for better or for worse, the attitudes of our young people are forged and tempered. Assuredly this will take time, and worse yet it will take individual effort from all of us as individuals, but in my opinion it is the *sine qua non* for true education on a national scale.

Preparation for College

What can we as individuals in the field of higher education, and in the industrial world, do to improve the college preparation of our young people? In the first place we must stop the once popular activity of college people of standing on the sidelines and criticizing the secondary schools. Although in some respects their product is unsatisfactory from our point of view, I believe that they have done an outstanding job considering the conditions with which they have had to contend.

The first essential to the unitary concept, which I mentioned earlier, is to find out for ourselves what the secondary schools actually are doing and help them to the utmost in weaving their engineering and scientific preparatory courses into the fabric of over-all engineering education.

In my opinion, all of us as individuals in our own communities must work through P.T.A. associations, service clubs, school committees, and other appropriate groups to see that our most immediate concern is with the *quality of education* within the school. We must consider elaborate buildings, gymnasia, auditoria, etc. in their true perspective, namely as aids to education, rather than as primary objectives in their own right. The Soviets are a perfect illustration of the fact that the quality of education is by no means dependent on the quality or adequacy of the housing. I do not for a moment deprecate the need for excellent school buildings, but all too often these structures themselves have become the ends and not the means to an end.

Most communities have lost sight of a very important aid to good education which, strangely enough, adds nothing to the school committee budget. This is the opportunity to add prestige and dignity to the teachers in our public schools.

Furthermore, without this prestige, no additional amount of salary increases will, in itself, produce the atmosphere which we desire.

If we will, we as members of our own communities can do much to initiate a revival of this prestige through the influence of families on the attitudes of their children. Certainly it is important to improve the salary situation but I repeat emphatically that this alone is not enough. Allied with the prestige factor is another area in which we can exert beneficial influence. This is in the support of the present teachers in our educational systems who are trying to do a good job. Far too often, teachers who are trying to enforce rigorous standards are frustrated, and are brow-beaten by parents and children with little or no support from their superiors. We should throw our support behind the people in this situation; and they exist throughout the land.

The Undergraduate Program

What must be do in connection with our undergraduate program to increase the educational content of the process, and to insure the production of students better able either to enter industry or to go in increasing numbers to graduate school?

One important aspect, in my opinion, is an intensified and continuing emphasis on good teaching. I am sure that all of us appreciate that teaching is the fundamental business of the college, and that a very major portion of the value of research, consulting, and of faculty publications is the enhancement of the quality of teaching in the institution. However, in spite of our basic interest in, and agreement with this concept, accomplishments in research and in authorship stand out clearly from the routine of educational operations and lend themselves easily to prestige and recognition. The identification and public recognition of good teaching in the classroom, however, is much more difficult. Consequently, in too many institutions the administration becomes submerged in the detail of educational supervision, and high quality and imaginative teaching receives so little recognition that the faculty become confused and wonder whether or not the administration really cares about top level performance in the classroom. Well thought out programs of publicly recognizing these "virtuosos of the classroom" would pay great dividends in faculty morale and in increased classroom effectiveness. A share of this recognition should go to the faculty members who have had sufficient initiative and energy to devise appropriate teaching aids to increase the efficiency of their presentation.

An element which needs very thoughtful attention is that of determining in each institution the proper balance between instruction in engineering and in science. Certainly we need to turn out much more theoretical engineers than it has been our practice to do in the past.

Actually this is not at all a new concept but has been the historic trend ever since the first college of engineering was founded.

In our zeal to accomplish this desirable result, however, there is danger that we shall lose sight of the real difference between a theoretically trained engineer and a scientist. It would be most unforunate, in my opinion, if all colleges of engineering suddenly were to devote their attention to the graduating of pseudo-scientists rather than of engineers.

Much will be gained in effectiveness and in understanding when we are able first to teach the applicable broad basic theory to all of our engineering undergraduates in terms of general laws and principles and then to apply the appropriate segments of these general laws to the specific requirements of the individual courses. This we must assiduously work toward rather than to teach a separate set of basic theories which represent specialized applications in the individual courses in engineering science.

In the main, however, neither our faculties nor our textbooks are currently prepared to teach this re-aligned approach. The effectuation of this ideal will require faculty with a background which is both broad and penetrating, and a whole new generation of textbooks. The mere fact that this is a difficult transition, however,

should not deter us from taking the initial steps as rapidly as practicable.

There is an opportunity in most of our engineering colleges to improve the educational value of the curriculum. Far too many of our courses place a premium on keeping the student busy rather than insuring a maximum of thought on the part of the student. We must be prepared to permit and encourage our faculty to maximize the thinking content in their courses. This type of teaching is much more demanding, and although it is more interesting and challenging, in many cases it requires a break with tradition and the expenditure of greater effort and time on the part of the faculty member.

A strange phenomenon in many colleges of engineering is the lack of usage of advanced mathematics in upperclass engineering courses. In too many institutions, although the students study mathmatics at least through differential equations, all of the upperclass design work can be passed with moderately inaccurate arithmetic. If you doubt this statement, I invite you to examine critically the textbooks being universally used in our colleges.

Professionalism

Another aspect of engineering education to which I hope our engineering teachers will devote increasing attention is that of developing professional attitudes in our students. The unfortunate part of this is that it can only be done most efficiently by example. Do we, or will we, take the trouble in our professional departments to inculcate a spirit of professionalism in students at all levels in the undergraduate program? If we believe that engineering is or can be a profession, it well behooves us to inculcate its tenets into our students.

Graduate Work—Preparation for Teaching

Are we doing everything we can to call to the attention of our good upperclassmen the importance of full-time resident graduate work, and the desirable aspects of teaching as a profession? It is a severe indictment of our ability, judgment, or both if we have remained as many years as we have in a profession which does not have some outstandingly desirable features. We must continually and enthusiastically sell a career in teaching to our good students. Much more emphasis early in the undergraduate program should be placed on urging and inclusion of teaching in the students' consideration of career possibilities.

Accreditation

Since the ECPD accrediting process is so inextricably interwoven with our system of higher education in engineering, I would like to comment on certain aspects of its operation. In my opinion, the activity of the committee on engineering schools, now the committee on education, is the most important single event in engineering education of the last thirty years. Great benefits have accrued, and this can continue in greater measure in the future.

This activity can continue to be a most constructive influence in engineering education or can develop into an autocratic monster depending both upon its leadership and upon the initiative and interest of the members of ECPD in carrying out their share of the democratic process built into the organization.

Constant efforts will need to be exercised to avoid standardization. This has clearly been the aim of the leaders in ECPD since its inception. However, at the level of the college, there is continuing danger that the weaker schools will accept a program which they know has been approved elsewhere, without scrutiny to see whether this program is suitable to their faculty and their particular situation.

A second need, in my opinion, is to broaden the effective participation of other members of ECPD. This will make possible the democratic action intrinsic in its organizational structure, and in the long run should be beneficial both to the colleges and to the members from industry.

Continuing attention should be devoted to the training and indoctrination of inspectors. This will insure that the high quality in inspections which has

been found to be the rule by most institutions will become the universal experience.

Graduate Instruction

We must develop ways and means of getting greater numbers of our first-class graduates to enter full-time resident graduate programs and continue on to the terminal degree. Since these people are most important to industry and are becoming more sought after each year, we can only satisfy our needs in engineering teaching by producing a much larger number of men with the doctorate.

Since students are usually directed into teaching by some experience in its satisfactions, it is essential that larger numbers of our doctoral candidates become associated with teaching fellowships. One step in this direction would be to modify the Defense Education Act to permit a sufficient span of time to the graduate fellows to enable them to do part-time teaching.

One very important aspect of this is that we must convince our industrial members and friends that they should defer picking from the vine our best graduates with a Bachelor's degree until they have been further ripened by graduate work.

The evening graduate programs are doing a great deal of good for industry but since these students are already committed to jobs, it is unlikely that they will help to cut down the shortages of advanced degree holders in the teaching profession. Nevertheless, they may well serve to take off some of the pressure for graduates from our full-time resident advanced programs.

Summary

The points which I have tried to make here are:

1. Regardless of whether we are in industry or in education, as intelligent citizens we must assume personal and individual responsibility for the educational development of the student throughout the spectrum of formal programs from high school through graduate school.
2. We must take every conceivable step to improve the educational motivation of our students.
3. In our own communities we must fight for the highest possible quality of instruction.
4. We must conscientiously work to improve the status and recognition of public school teachers.
5. We must continually emphasize the importance of inspiring undergraduate teachers.
6. We must provide up-to-date theoretically oriented instruction in *engineering.*
7. We must maximize the educational content of all courses.
8. We must increase the usage of higher mathematics in upperclass engineering courses.
9. We must improve accreditation procedures.
10. We must maneuver more of our better B.S. graduates into full-time graduate programs preferably leading to the doctorate.

Gentlemen, when we have successfully accomplished these things we will have struck a real blow for engineering education.

A Week of Accomplishment

The 1959 Annual Meeting of ASEE

Sacred cows were in open season during the Annual Meeting of ASEE in Pittsburgh last June. Nearly 1,500 engineering educators spent a productive week in defining the major problems that face engineering education and in the search for solutions to those problems. Every aspect of engineering education was examined critically and forced under candid discussion to stand or fall on its own real merits.

It was a working meeting. No radically new developments were revealed, no startlingly new ideas rocked the meeting. But the ideas stimulated or exchanged there, the friendships established there, and the decisions taken there both by smaller groups and by the governing bodies of the Society will affect engineering education for years to come.

Engineers for a dynamic world were the concern of the educators who are going to have to educate them, and this was also the theme for the first general meeting Monday afternoon. The tools and techniques for future engineers were outlined by the first group of speakers, and then a second group discussed how ASEE can meet the challenge of the future as a significant force in engineering education. The development and application of new knowledge in engineering education were cited by Harold L. Hazen, dean of the graduate school at M.I.T., as placing "heavier demands upon the intellectual qualities and attainments of our future engineering faculties. More than ever the life of the professor must be the life of a student." To point up the need for a sound foundation in the fundamentals underlying engineering, Dean Hazen said, "We must accept as an obvious working assumption that our student today will have to learn at least one and probably several new fields during his professional life." These may be fields which are not yet even imagined and so cannot be taught now.

The well known theme song of learning fundamentals has a new significance now, Dean Hazen said. The student must not only learn fundamentals, but he must also learn how to learn on his own, so that he can master the new fields that will develop in the course of his active career. If the student is to acquire this ability to learn on his own, the faculty must provide the proper atmosphere by cultivating its own skill in assimilating new experiences. Professors must more than ever before remain active students by means of research, formal study as in summer programs, and personal study.

In introducing the session on engineers for a dynamic world, Dean W. L. Everitt of the University of Illinois said that engineers must be given two types of tools, which he called Class A tools used by the engineer himself, and Class B tools used by technicians. The basic Class A tools, Dean Everitt said, are imagination, awareness, creativeness, resourcefulness, self-confidence, flexibility, literacy, and a sophisticated knowledge of modern science, including psychology, and the use of science in engineering.

Role of ASEE

The Monday general session later turned its attention to how ASEE can meet the challenge that this dynamic world is offering to engineering education. Dr. Eric A. Walker, President of Penn State, said that the role of ASEE and of engineering education should be reexamined on the basis of three points. First, engineering is a profession that involves social and moral responsibility as well as technical competence.

Second, engineering should assume leadership in certain areas. This involves the question of whether engineers are to remain only "servants of society," as they

One day of the program was devoted to tours of the industries in the Pittsburgh area. Pictured here are some of the members of the Society who spent the day at Gulf Research & Development Company, being shown a pilot plant in operation by Gene P. Hulin, a chemical engineer with the Process Development Section of the Process Division.

are described in the Grinter Report, or whether they will assume leadership for the well-being of mankind. If it is to be the latter, Dr. Walker said, engineering education must change its point of view. The third point offered by Dr. Walker as a basis for a reexamination is the realization of the change of engineering in the direction of the exact sciences.

With these points as a basis, Dr. Walker offered for the meeting's consideration a series of questions. Is engineering getting its fair share of the bright students coming to college? Are four years enough to educate competent engineers and would five be better? Should more engineers be encouraged to get the master's degree? Are there enough technicians for every engineer, or if there are not, is it because of a real shortage or because of management policies? What role should continuing education play in the career of the engineer? And finally, why are so few engineers on the major advisory boards?

Such questions continued to be asked throughout the week-long meeting, and some answers were proposed. Mervin J. Kelly, research management consultant speaking before the Cooperative Education Division on Thursday, suggested a sweeping revision of the present four-year engineering education programs to enable graduates to keep pace with the urgency for speed in incorporating new scientific knowledge into new technology. He said that the present engineering graduate's education in science and mathematics is inadequate, and suggested that today "four years of study is too short a period for the required depth of coverage."

Technical Institutes

The problem of "status," both of institutions and their graduates, is the "all pervasive problem" facing two-year technical institute education in the United States, according to G. Ross Henninger, president of the Ohio Mechanics Institute and director of ASEE's survey of technical institute education. "There is in the industrial and professional complex of the United States no generally accepted pattern of professional recognition for the engineering technician," he said. "Only a relatively small number of industrial firms thoroughly understand the technical institute ideas and accordingly have clearly recognized and integrated the engineering technician into their forces of technological manpower."

Though it is not generally accepted or understood, Henninger said, technical institutes have a "limitless" potential to supplement other forms of technological education in the United States.

Henninger's address to the Monday session of the Technical Institute Division was a summary of a three-year national survey of technical institute education made possible by a grant from the Carnegie Corporation. Other problems reported in the survey are how to keep curricular offerings up to date in terms of trends in technology and new manpower needs, how to attract more students to study in technical institutes to fill the needs for their graduates in industry, and how to procure industry-oriented, experienced personnel for technical institute instructors.

Research in Education

Are we ready to apply scientific methods to our development of teaching? This question was asked of the Educational Methods Division by Professor O. E. Lancaster of Penn State. In 67 years of the Society we have not developed a body of knowledge of education equal to the bodies of knowledge developed by other professional societies, Lancaster said. We teach now in much the same way we did 30 years ago. If engineering is the professional art of applying science, more science should be applied to engineering teaching. In advocating a more vigorous program of educational research, Lancaster set forth the series of steps in carrying out educational research. The final step, which the JOURNAL heartily endorses, is the publication of the results.

Dr. Eric Walker, in urging research on both engineering curricula and teaching methods, pointed out that most ASEE efforts in this direction are *studies*, not *research*. He said that basic educational research is needed in colleges of engineering to resolve differences of opinion on many issues and to provide answers anchored in fact. He suggested that educational research by engineering faculties would not only provide answers to many questions which trouble engineering educators, but would also provide the leadership necessary if education generally is to learn to produce quality in quantity in education.

One of the areas of current disagreement mentioned by Walker is the question of how much of the humanities and social studies should be included in the engineering curriculum. Another problem on which light needs to be shed, he said, is that of fragmentation and course proliferation in engineering. Furthermore, we need to get some facts as to the value of television as a teaching aid. Television will never replace the good teacher, he emphasized, but if we can put our prejudices aside we may find how it will help the good teacher to do a better job.

Faculty Problems

Money is not the only reason college teachers desert the campus for other careers, according to a report made by Professor A. R. Hellwarth, Assistant Dean of the College of Engineering at the University of Michigan and chairman of the ASEE committee studying loss of faculty to industry. A survey of 235 college teachers of engineering who left their schools since June 1954 shows that security, including income and fringe benefits, was the dominant factor for leaving teaching, but it was closely followed by some degree of dissatisfaction with the work, the work load, facilities, and the educational policies of the

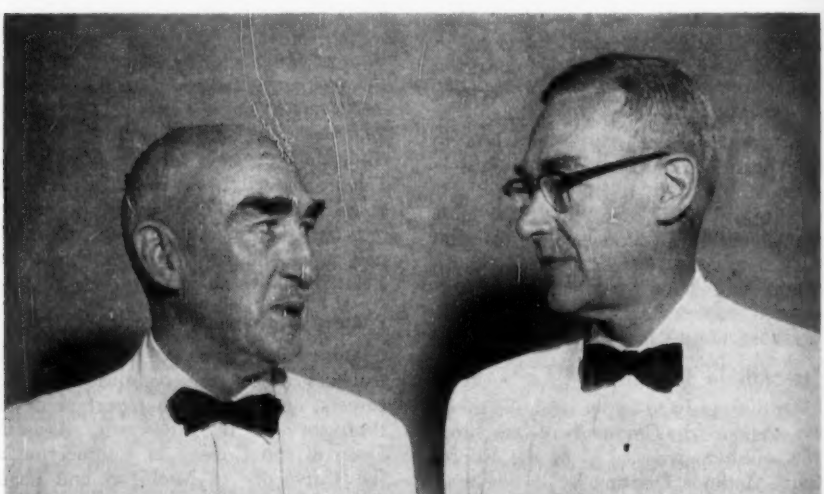
institution. Of course in some cases the teacher just didn't like his boss.

Other factors influencing the teacher to leave were a desire for new experience, and for more challenging or interesting work; personal factors, family, environment, health, geography, or climate; lack of recognition or appreciation by the college, community, or society; unavailability of permanent position, tenure, or opportunity for advancement.

The report indicated that 70% of those who left teaching had been on the staff for 3–15 years, were 25–40 years old, and in most cases were considered permanent faculty members. Because of the high percentage in this group, the committee advocated additional emphasis on recognition of the teacher as a person who merits the same consideration as does an employee in any other situation.

The survey did show, also, what engineering teachers considered to be the advantages of a teaching career. The primary attraction mentioned by most was the satisfaction of teaching, the association with young people, and the feeling that one is doing something that is of value to society. Other advantages mentioned were personal freedom to think, explore, select areas of work and research; time freedom, flexible working hours, vacations; academic environment and atmosphere and working with a high level of professional associates; less pressure or competition; opportunity for professional growth and advancement; feeling of stability and security; and prestige. These are the attractions that need to be called to the attention of young engineers as they plan their post-college careers.

The report suggests to administrative heads, "The desire of the teacher to continue his relationship with his school will be a reflection of the school's interest in him as a person and its recognition of



At the Annual Banquet on Thursday night, Dean William T. Alexander (left) of Northeastern University, ASEE President for 1958–59, presided and presented the awards. Dr. Dael Wolfle (right), Executive Director of the American Association for the Advancement of Science, was the Banquet's distinguished speaker.

him as a professional man with all the economic and social benefits pertaining thereto."

Accent on Humanities

The emphasis on the engineer's social and moral responsibilities that ran through the general session on Monday cropped up several more times in the course of the week. Hugh L. Rusch, vice-president of Opinion Research Corporation, told the ECAC-ECRC banquet Tuesday night that just as engineers have been effective in dealing with forces of our physical world, they must now become effective in dealing with the forces of our society. "Just as the industrial world has established very fine physical and chemical laboratories for the benefit of the human race, there is now need for another laboratory which we call, for want of a better term, a research department for better human relations."

Dr. Dael Wolfle, executive officer of the American Association for the Advancement of Science, at the Annual Banquet Thursday night called on ASEE members to "make such contributions as we can to the planning of the social and economic framework in which the engineer of tomorrow will work." Scientists and engineers must accept greater responsibility for the social problems which they have helped to create. "We can no longer permit the power of science and engineering to grow in an unplanned and uncoordinated fashion. As the agents responsible for this growing power, we must devote part of our energies to the task of planning future development and the conditions under which we and our children will live," Dr. Wolfle said.

Dr. Wolfle made three specific recommentations: 1) there must be greater support—moral as well as financial—for social science, emphasizing the most fundamental work in the social studies; 2) we must do better social, economic, and educational planning, so that we can better foresee the problems which scientific developments will pose for us and the environment in which they will require solution; 3) we must encourage social innovation. "Substantial social change will be necessary to adapt to and to take full advantage of the growing power of science and technology."

Guests of Industry Day

The Engineering College Research Council gave up its usual Wednesday general session this year for the special Guests of Industry Day program. Conferences and tours of industrial plants in and around Pittsburgh were scheduled by most divisions of the Society. The companies which very graciously played host for the day were Jones and Laughlin Steel, Westinghouse Electric, Dravo Corporation, United States Steel, Gulf Research and Development Company, the Aluminum Company of America, Pittsburgh Plate Glass Company, as well as the U. S. Bureau of Mines and the Mellon Institute of Industrial Research. This program was included this year to take advantage of the opportunities afforded by the location of the meeting in one of the nation's leading industrial areas.

Social and Family Events

The annual meetings of ASEE have long been known as "family"" meetings, with plenty for the wives and all ages of children to do while the members are attending to their professional concerns. This meeting was no exception, and the women's program, under the chairmanship of Mrs. Walton Forstall and Mrs. James Coull, and the young people's program, under the chairmanship of L. N. Canjar and W. M. Rohrer, provided an interesting and varied week for the more than 400 women and nearly 200 children who came to Pittsburgh for the meeting.

Space does not permit any adequate report of the social events of the week in Pittsburgh. Some of the high points were the mixer Monday night, the President's reception Tuesday evening, the smorgasbord Wednesday evening, and of course the Annual Banquet Thursday. The arrangements for these and all the dozens of other events of a busy week

were well arranged by the Pitt and Carnegie Tech hosts of the meeting.

Official Steps

Several important decisions were made in the Executive Board and General Council meetings that were held during the annual meeting. For the details of these official actions and the reasons behind them, read the new feature, "What's Going On in ASEE?," which begins with this issue.

Massive Gothic appetites matched the architecture at the Smorgasbord in the Common Room of Pitt's Cathedral of Learning. The Smorgasbord was a fitting general gathering at the end of Wednesday's "Guest of Industry Day."

ENGINEERING BOOKS SOUGHT FOR SEATO

The SEATO Graduate School of Engineering is being established in Bangkok, Thailand, under the direction of Colorado State University Research Foundation through a contract with International Cooperation Administration. A comprehensive reference library is planned to serve the staff and students, initially in the field of Civil Engineering and later in Electrical Engineering and Mechanical Engineering.

If you have, or know of anyone who has, engineering literature in the form of periodicals, books, manuals, microfilms, special reports, etc., a contribution to the library would be very valuable. Please write to: Dr. Maurice L. Albertson, Director, Colorado State University Research Foundation, Fort Collins, Colorado.

What's Going on in ASEE? [1]

W. LEIGHTON COLLINS, Secretary

The Executive Board met in Chicago, Illinois, on April 25 and 26. Significant in the actions on membership was that Youngstown University was voted to be eligible for active membership and that a request for appropriate action was referred to ECAC and ECRC. A similar action was taken in regard to Valparaiso University, except that it wishes to participate only in ECAC. The Harvey Mudd College and the Pennsylvania Military College were elected to affiliate membership.

Initial copies of the brochure "Teaching Tomorrow's Engineers" were distributed. Twenty thousand copies were printed and they are to be made available to deans of engineering, at no cost, through the Office of the Secretary. The national office of Tau Beta Pi is urging local chapters to cooperate with deans of engineering in getting local programs underway. The deans also are to be informed that M.I.T.'s booklet "You and Your Students" can be ordered from the ASEE office at a cost of 25¢ each for single copies or 20¢ in amounts greater than five dollars, and that quantity orders of "College Teaching as a Career" should be obtained through the institution's supply or directly from the American Council on Education.

ASEE-AEC Summer Institutes

The Nuclear Committee was authorized to make plans for the 1960 ASEE-AEC Summer Institutes. The Executive Board also *VOTED* to endorse the following two recommendations of the Nuclear Committee:

1. That the ECPD-accredited requirement for eligibility be omitted for the Summer Institute programs (but not including the technical institute program) and that each applicant be considered on an individual merit basis. It is probable that the additional attendees would come from institutions qualifying for the Special AEC Fellowships in Nuclear Engineering and from other institutions having active nuclear programs.
2. That technical institutes be included in the AEC program for "Assistance in Acquisition of Teaching and Demonstration Aids in Nuclear Energy Technology."

The Executive Board also *VOTED* to approve the recommendation of the Nuclear Committee that no Nuclear Congress be held in 1960, and that the Nuclear Congress not be held more often than every other year.

New Officers Elected

The results of the mail ballot for officers for 1959–60 were made a matter of record, and B. R. Teare, Jr., R. G. Owens, H. W. Barlow, and W. W. Burton were duly declared elected.

The request of the Pacific Southwest Section to apply to a private foundation for the $7,500 per year for three years for its operations instead of raising the money from local industry was denied. The Executive Board *VOTED* that it was not in the best interests of the Society to approve the request of any Section to solicit funds from a national foundation for a Section operation, but reaffirms its previous action relating to local support.

The Executive Board voted to approve the statement made by CDEF, and attached hereto as Appendix "A," on changes desirable in the National Defense Education Act of 1958. The Technical Institute Division also was to be

[1] By action of the Executive Board only abstracts of the minutes of its meetings and meetings of the General Council are published in the JOURNAL. Anyone wanting a complete copy of the minutes may obtain them by writing to the Office of the Secretary.

asked for a comment regarding the aspects of the Act pertaining to its area of activity which should be changed.

The appropriate resolutions of ECPD and EJC relative to the amalgamation of the two organizations, which had been approved by letter ballot, were voted into the record, with particular emphasis on the unanimity of the favorable vote. The letter ballot decision favoring the incorporation of IASTE in EJC also was made a matter of record. The request of EJC for a contribution of $47.50 to help defray the cost of six advertisements in "Editor and Publisher" was disapproved.

Atomic Manpower Survey

The U. S. Department of Labor requested the endorsement of the Society in making a second survey of educational institutions for a determination of the manpower requirements in atomic energy activities. At the request of the AEC the Department of Labor was making one comprehensive survey instead of having the work divided into three parts, as in the past. The endorsement and support was granted, provided the schools having one or more curricula accredited by ECPD would be coded so that the results could be separately tabulated and submitted to ASEE for evaluation.

The desirability of recognizing scholarship was discussed at considerable length. It was finally *VOTED* that certificates be designed for honoring and recognizing the freshman, sophomore, junior, and senior engineering students with the highest scholastic standing, the certificates to be suitable for framing and for presentation at appropriate convocations of member institutions desiring to participate in the plan.

As a result of the current EJC study of decreasing engineering enrollment the Executive Board *VOTED* that President Alexander, Vice President Van Houten, and Treasurer Gammell prepare a carefully worded statement emphasizing the excellence of an engineering education as a discipline, bringing out that in the modern world engineering is a cultural education challenging to the best of minds, and calling attention to the breadth of ultimate job potential available to the engineer. The proposed statement is to serve as a basis for a new release and is to be submitted to ECPD for possible use by its Guidance Committee.

The Carnegie Institute of Technology presented a proposal for the sponsorship of a Conference on Engineering Analysis and Design in the summer of 1960, and Iowa State College presented a similar proposal for a 6 to 8 week program on the Nature and Properties of Materials. The Executive Board *VOTED* to support each of the programs and to encourage the institutions to proceed with the drafting of proposals for submission to the National Science Foundation and for final action at the June 1959 meeting of the General Council.

Study of Teaching

The Executive Board also *VOTED* to authorize President-elect Teare to proceed with the negotiations with the Ford Foundation for a sum not to exceed $25,000 to be used to meet the expenses of a select committee to prepare a proposal for the comprehensive study of problems in the teaching of engineers. Vice President Wendt is responsible for the drafting of the proposal, and President Alexander, Vice President Morgan, and Vice President-elect Barlow are to aid in the selection of the committee.

The responsibility of ASEE in aiding foreign countries with their problems in engineering education was discussed at great length. It was finally agreed that ASEE's policy be a willingness to serve in advisory and consulting capacities and in the making of surveys, but not in an operational capacity. It was believed that ASEE is uniquely qualified to assemble groups and attract qualified personnel for the purposes stated and does have a responsibility for aiding engineering education in foreign countries if we are able to do so. In other actions relating to international activities the proposal from the International Relations Committee requesting a grant for "Practical Experience for Foreign Students in the U. S." was referred to IAESTE for appraisal and comment, and the invitation from the Institute of International Educatio

to be one of fifteen organizations represented on a Continuation Committee for the planning of National Conferences on Exchange of Persons was accepted.

The appointments of W. Leighton Collins as Secretary and Paul T. Bryant as Editor of the JOURNAL for one year beginning September 1, 1959 were approved, the determination of salaries to be made at a later date. The employment of a half-time assistant Secretary was authorized, the Executive Board agreeing to recommend to the General Council an increase in individual dues of $1.00 per year, effective July 1, 1959, to provide the necessary funds for all expenditures related thereto. It also was voted that in future contracts for special projects a 5% administrative charge, in addition to direct costs, be negotiated.

The Secretary was encouraged to prepare a proposal to provide funds for various items which would meet the requirements of the National Science Foundation for grants in "support of scientific publications."

The meeting adjourned after almost 13 hours of deliberations.

NSF COOPERATIVE GRADUATE FELLOWSHIP PROGRAMS

Approximately 1,000 Cooperative Graduate Fellowships will be offered by the National Science Foundation in support of graduate study in the sciences, mathematics and engineering during the academic year 1960–1961. Fellows will be selected solely on the basis of ability as indicated by reference reports, academic records, and other evidences of attainment, including scores received on nationally administered examinations designed to test scholastic aptitude and scientific achievement.

Applicants will apply through the participating institution of their choice and will be initially screened and evaluated by the faculty. Applications will be forwarded—together with the institution's recommendations—to the National Science Foundation. Applicants will then be evaluated for the National Science Foundation by panels of scientists especially chosen for this task by the National Academy of Sciences-National Research Council.

Tenures of nine or twelve months are optional with the Fellow. Fellows will receive a basic annual stipend of $2,200 from funds provided by the National Science Foundation and will be encouraged to undertake limited teaching responsibilities. At their discretion, the institutions themselves may supplement the stipend by as much as $800 for a Fellow on a full year's tenure or $600 for those on the shorter tenure. In lieu of tuition and fees, the Foundation will provide each institution a predetermined and standardized cost-of-education allowance on behalf of each Cooperative Graduate Fellow.

To be eligible, candidates must be citizens of the United States by March 1, 1960 and must have demonstrated ability and special aptitude for advanced training and productive scholarship in the sciences.

Application materials can be obtained from the Graduate Dean of a participating institution or from the Fellowships Section, Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C. Applications must be submitted to the Graduate Dean of the participating institution of the applicant's choice by November 6, 1959. Shortly after March 15, 1960, all applicants will be notified, by the schools through which they applied, of the disposition of their applications.

THE LAMME AWARD

The Lamme Award consists of a gold medal and bronze replica bestowed annually upon a distinguished engineering educator for excellence in teaching and contributions to the art of teaching; contributions to research and technical literature; achievements which contribute to the advancement of the profession; and engineering administration. The Lamme trust fund was established in memory of Benjamin Garver Lamme.

GORDON STANLEY BROWN, Professor and Head of the Department of Electrical Engineering at the Massachusetts Institute of Technology, and recently named Dean, has achieved an unusual balance of significant contributions in engineering teaching, research, and educational administration. Born in Australia in 1907, he earned M.E. and E.E. diplomas from the Melbourne Technical School in 1925. At M.I.T. he earned the S.B. degree in 1931, after being a member of the Honors Group in both his junior and senior years, the S.M. degree in 1934, and the Sc.D. degree in 1938—all in electrical engineering. In 1931 he was appointed Research Assistant in Electrical Engineering at M.I.T., an Instructor in 1932, and by 1952 head of the department. He also taught at Purdue University and the University of California as a visiting professor and received the honorary degree of Doctor of Engineering from Purdue. Experience in industry as an engineer and consultant, and service as a member of various advisory bodies of the armed services are additional aspects of Professor Brown's experiences.

A member of ASEE since 1946, Professor Brown has made outstanding contributions to engineering education. He has long been recognized by colleagues and students as an enthusiastic, effective, and stimulating teacher whose students have augmented his high reputation by compiling fine records of achievement in both industry and education. In recent years he has become particularly well known for his vigorous, courageous, and farsighted leadership in re-evaluating the standard concepts of engineering education and in moving forward in the teaching of engineering science to meet our needs for leadership. As head of electrical engineering at M.I.T. he has established a fundamental program in electrical engineering, eliminated options, and consolidated the department's activities into the areas of electrical energy processing and information processing. Courses leading to the M.S. degree have been established in electrical science and engineering which have increased depth in science and mathematics and include a heavy accent on the physics of materials.

In 1957 Professor Brown organized a national conference of professors from more than 100 schools to disseminate the results of the work of his department and to bring about an exchange of educational views among the electrical engi-

To GORDON STANLEY BROWN, *engineer, scientist, teacher, administrator; for his pioneering work on the theory of automatic control and his leadership in its introduction into engineering education; for his vision, energy, and leadership in creating and making effective a new synthesis of education in the electrical engineering sciences; for his publications on scientific subjects and on topics of engineering education; for his untiring efforts to advance professional education in engineering; for the warmth of his personality, his sterling character, and his unselfish devotion to the interests of faculty and students, we present this thirty-second Lamme Award.*

neering departments of universities in the United States and Canada. He was also one of three consultants selected to review the program of Dartmouth College's Thayer School and is now on that school's Board of Overseers. This kind of initiative and interest in the development of engineering education has made Professor Brown's influence for progress felt far beyond the limits of his own department and institution.

Gordon Brown's leadership in the education of engineers is not a recent phenomenon, nor has it only recently been recognized. In 1952 he received ASEE's George Westinghouse Award, which is presented for "outstanding contributions to the teaching of students in engineering." He thus becomes the first to receive two of ASEE's major awards.

Outstanding work as an educator is matched by equally impressive research and publications. As Director of the Servomechanisms Laboratory at M.I.T. from 1941 to 1952 and as an active research worker throughout his professional career, Professor Brown has published an impressive list of articles on cosmic rays, instrument engineering, and automation. With D. P. Campbell he wrote a book on his special field, *Principles of Servomechanisms*. As an administrator he has kept his department in the forefront of an area of education in which new developments constantly raise new challenges.

In engineering education and research, Gordon Brown has displayed vision, courage, initiative, and a high level of creative intelligence in a critical time when the nation and the world can do with nothing less.

THE GEORGE WESTINGHOUSE AWARD

The George Westinghouse Award was established by the Westinghouse Educational Foundation in 1946 as an annual Award to young engineering teachers of outstanding ability to recognize and encourage their contributions to the improvement of teaching methods for engineering students. The award consists of $1,000 in cash and an appropriately engraved certificate.

MAX STONE PETERS was born in Delaware, Ohio, in 1920 and received the Ph.D. in Chemical Engineering from the Pennsylvania State University in 1951. He obtained his elementary and high school education in the public schools at State College, Pennsylvania. At the present time he is Head of the Division of Chemical Engineering at the University of Illinois. Professor Peters has combined his administrative duties with undergraduate and graduate teaching, activity on national education committees, student counseling, and research. At one time or another during his teaching career, he has taught almost every undergraduate chemical engineering course, and he has taught several graduate courses. Because he feels that research is an essential part of an education program he is active in directing both undergraduate and graduate research.

After receiving the B.S. degree in chemical engineering from the Pennsylvania State University in 1942, Professor Peters worked for two years in industry as Production Supervisor for the Hercules Powder Company. He then served for two years in the United States and Italy with the U. S. Mountain Infantry before returning to Penn State for his M.S. in 1947. From 1947 to 1949, he was Tech nical Superintendent for the Geo. I Treyz Chemical Company. After receiving his Ph.D. in 1951, Professor Peter joined the Chemical Engineering staff a the University of Illinois as Assistant Professor of Chemical Engineering. He wa made a full professor in 1957 and wa appointed Head of the Division of Chemical Engineering in 1958.

In addition to having published ap proximately twenty scientific papers, Professor Peters has written two books which have been widely adopted for classroom use. The first book, *Elementary Chemical Engineering*, was published by the McGraw-Hill Book Company in 1954 and the second, *Plant Design and Economics for Chemical Engineers*, was published by the same company in 1958. His research is in the field of kinetics and mechanisms of chemical reactions, which ties in directly with the graduate course he has developed on chemical engineering kinetics.

As Head of the Division of Chemical Engineering at the University of Illinois Professor Peters has introduced a modernized revision of the curriculum. Recognizing the fact that chemical engineering graduates engage in a tremendous

To MAX STONE PETERS *for his interest and enthusiasm in improving Chemical Engineering education at both the undergraduate and graduate level; for his original and valuable textbooks; for his foresight in the organization of a more strongly science-oriented Chemical Engineering curriculum; and especially for his sympathetic guidance of students at all levels, we present this fourteenth George Westinghouse Award.*

scope of activities ranging from economics and technical service to laboratory research, he has initiated a science-oriented curriculum which gives the student flexibility in planned substitution of courses such as advanced mathematics, physics, and chemistry for more conventional courses. He is Chairman of the Education Committee of the American Association of Cost Engineers and is currently engaged in an attempt to improve teaching in this area. He is also a member of the Program Committee and the Professional Development Committee of the American Institute of Chemical Engineers. Among his many activities in ASEE, Professor Peters organized and was chairman of the session on Design and Economics at the Fourth Summer School for Chemical Engineering Teachers in 1955. He also received First Prize for the best paper on engineering education at the Illinois-Indiana Section ASEE meeting in 1954.

Much of Professor Peters' deep interest and insight in education was inspired by his father, Dr. Charles C. Peters, who was a noted educator in the College of Education at Penn State. In addition to the influence of his father, Professor Peters also feels that his friend and teacher, Dr. M. R. Cannon of the Chemical Engineering Department at Penn State, was one of the major motivating factors in directing and influencing his career.

THE VINCENT BENDIX AWARD

The Vincent Bendix Research Award consists of a gold medal and citation conferred annually for outstanding research contributions, either in original thought or administrative leadership, to a staff member of the colleges of engineering in the United States. The Award was established through the efforts of the Engineering College Research Council and the Bendix Aviation Corporation. The latter granted funds to establish the award in 1956.

ROBERT FRANKLIN MEHL was born in Lancaster, Pennsylvania in 1898. His early interest was in the field of chemistry, in which he majored at Franklin and Marshall College, graduating in 1919. He continued his education at Princeton University, holding a Proctor Fellowship during 1922–23. He became Head of the Department of Chemistry at Juniata College in 1923 and completed the work for the Ph.D. degree in physical chemistry at Princeton University in 1924.

A National Research Fellowship took him to Harvard University in 1925 where he studied metallurgy under Dr. Albert Sauveur. In 1927 he moved to Washington to become Superintendent of the Physical Metallurgy Division of the Naval Research Laboratory. It was while there that he successfully used radium as a source of radiation for industrial radiography, thereby presenting to the engineering world a truly portable method of nondestructive testing of metal parts and structures. In 1931 he was appointed Assistant Director of Research at the American Rolling Mill Company.

He was called to Carnegie Institute of Technology in 1932 as Professor of Metallurgy. He also was appointed Director of the Metals Research Laboratory which he organized ás an adjunct to the Department of Metallurgical Engineering so that teaching staff members and students could have the facilities and means of engaging in metallurgical research of an advanced nature and high quality. In 1935, he became Head of the Department of Metallurgical Engineering at that institution and in 1953 Dean of Graduate Studies.

He has been active in many professional societies, notably the American Institute of Mining, Metallurgical, and Petroleum Engineers and the American Society of Metals, in which he has held numerous committee posts. He has been honored by election to membership in the National Academy of Sciences, Phi Beta Kappa, Sigma Xi, and Tau Beta Pi. He is also a member of the Institute of Metals of Great Britain and the Associacao Brasiliera de Metais of Brazil.

He received the John Scott Medal for the development of gamma ray radiography in 1934 and the Howe Medal of the American Society for Metals in 1939. He holds a number of other medals including the James Douglas Gold Medal of the American Institute of Mining and Metallurgical Engineers awarded in

To ROBERT FRANKLIN MEHL, *whose name is virtually synonomous with modern metallurgy, for his pioneering study of the fundamental concepts of the nature and behavior of metals, for the vigorous research program which he has directed and in which he has personally participated, for his development of the nondestructive testing of metals, for his dynamic impact upon the careers of his many students and associates, for his many significant contributions to the literature of metallurgical engineering, for the worldwide recognition he has achieved, and for his leadership, scholarship, and genius, we present this fourth Vincent Bendix Award.*

1945, the Clamer Medal of the Franklin Institute in 1953 and the LeChatelier Medal of the Societé Francaise de Metallurgie of France in 1956.

He has been recognized both at home and abroad by invitations to give honorary lectures before scientific bodies which have taken him to England, France, and Brazil. His services as a consultant have been widely sought. He has served as a member of the Engineering Advisory Committee of the National Science Foundation, the Materials Advisory Board of the National Academy of Sciences, the Scientific Advisory Board of the Convair Division of General Dynamics, and as consultant for the Institute for Technical Research in Sao Paulo, Brazil.

Despite all of his professional activities beyond the academic cloisters, his major interest has been consistently devoted to education and metallurgical engineering research. He has never lost sight of two basic objectives which he has set as guides for those who work with him and under him at the Carnegie Institute of Technology, namely, to add to the storehouse of knowledge and to stimulate and educate engineers and teachers. His many publications, which span the period from 1924 to the present, and which are shared with so many of his students and associates, testify to his devotion to these objectives. His writings include books, papers, lectures, and translations of foreign texts. His study of gun steels has been called the most important contribution to gun tube manufacture. Within the American Institute of Mining, Metallurgical, and Petroleum Engineers, his papers have been judged best of the year no less than five times.

With all his many duties and activities he takes time to read books in fields other than metallurgy and occasionally to do oil painting, at which he is far from inexpert, an example of which recently was used for the cover of "Metal Progress."

THE CURTIS W. McGRAW AWARD

The Curtis W. McGraw Research Award was established to recognize outstanding early achievements by engineering college research workers and to encourage the continuance of such productivity in the future. The award was sponsored by the Engineering College Research Council with the assistance of the McGraw-Hill Book Company. The award consists of $1,000 in cash and an appropriately engraved certificate.

ROBERT BYRON BIRD was born in Bryan, Texas on February 5, 1924. He became interested in engineering and in academic work through the influence of his father, who is a distinguished civil engineer.

Dr. Bird received his B.S. degree in Chemical Engineering from the University of Illinois in 1947. His undergraduate work was interrupted by a three-year period of service in the Chemical Warfare Service, 1943–46. He rose to the rank of First Lieutenant and was awarded the Bronze Star Medal for meritorious service in combat in Germany.

His graduate training was in the field of physical chemistry taken at the University of Wisconsin, from which he received his Ph.D. in 1950. This was supplemented by a year at the University of Amsterdam as a Fulbright Fellow, 1950–51, and by a year as Project Associate in Chemistry at the University of Wisconsin, 1951–52.

Dr. Bird's teaching career began as an Assistant Professor in Chemistry at Cornell University, 1952–53. He then was invited to join the Department of Chemical Engineering, University of Wisconsin, as a Project Associate, with the assignment of developing a more fundamental approach to those problems of chemical engineering which involve the transfer of momentum, mass, and heat. In 1955, he was made Associate Professor, and in 1957, at the unusually early age of 33, was promoted to a full professorship, which position he now holds.

The research contributions of Dr. Bird have been made in the field of molecular theory of gases and liquids with particular reference to their transport properties, and in theoretical developments in fluid mechanics, heat transfer, and mass transfer. Through application of the Navier-Stokes equations, he has made important extensions of theories in the fluid mechanics of non-Newtonian fluids, in the motions of liquid drops, and in heat and mass transfer. He developed important engineering principles in calculating the flow of plastics in extrusion processes, and heat transfer to non-Newtonian fluids.

The results of his researches are given in some 40 papers, published in scientific and engineering journals not only in this country, but also abroad. He is co-author of two books, *Molecular Theory of Gases and Liquids* (1954), and *Notes on Transport Phenomena* (1958). The latter is receiving widespread attention

To ROBERT BYRON BIRD, *for his ability to translate into workable engineering procedures the findings of basic science; for the international prominence he has achieved through his mathematical studies and other researches in the field of molecular theory of gases and liquids; and particularly for the clear, lucid formulation of the transport integrals that enable the engineer to calculate precisely the transport properties of gases, we present this third Curtis W. McGraw Research Award.*

among enginering educators, and already is exerting a marked effect on curricula and instruction in chemical engineering.

Lectures on a variety of chemical engineering subjects have been presented by Dr. Bird to university groups, to technical societies, and to the technical staffs of various companies, both in this country and abroad. In 1957, he was invited to present a lecture on "Teaching of Transport Phenomena" at the Conference of Deans of Engineering. During the second semester of 1957–58, he held a Fulbright Lectureship at Delft, Netherlands.

Dr. Bird has a broad range of interests. He has unusual ability as a linguist, with a reading and speaking knowledge of Dutch, German, and French and a reading knowledge of Russian. When holding the Fulbright Lectureship at Delft, he delivered all of his lectures in Dutch. He is an accomplished organist, with a particular interest in the music of Bach. He is an outdoor enthusiast and has taken many extensive cycle and canoe trips.

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Other ASEE Awards

Besides the four major awards listed on the preceding pages, six others were presented at the Annual Meeting in Pittsburgh.

The James H. McGraw Award

Each year the Technical Institute Division presents to an outstanding contributor to Technical Institute education the James H. McGraw Award. Established in 1950 by the McGraw-Hill Book Company in memory of James H. McGraw, the award consists of $500 and an appropriately engraved certificate.

The Award for 1959 went to Professor **Henry Preston Adams** of Oklahoma State University.

Engineering Graphics Awards

The Distinguished Service Award of the Engineering Graphics Division expresses the deep appreciation of the Division and acknowledges by means of a certificate and a citation the many distinguished services rendered by a teacher of Engineering Graphics. The Award for 1959 was presented to Professor **Charles Elmer Rowe** of the University of Texas.

The Nomography Award of $100 was presented jointly to **R. Brown Ritter** and **John M. Lenoir** of C. F. Brown & Co. of Alhambra, California, and to **Joseph L. Schweppe** of the University of Houston, for nomographs appearing in *Petroleum Refiner*, November, 1958. This award is presented by the Graphics Division in cooperation with industry for the best nomogram published during the preceding year.

The Descriptive Geometry Award is presented by the Division in cooperation with industry for the best published article using descriptive geometry in engineering problem solutions. The Award was presented this year to Professor **Richard G. Huzarski** of the University of New Mexico for an article appearing in the March 3, 1958, issue of *Design News*.

Y.E.T. Paper Contest

The President's Awards are for the best papers written by members of the Society under 36 years of age. Each of the 16 Sections of the Society sponsors a contest and the winners are entered in the national contest. The first-place winner receives a check for $200 and the second-place winner a check for $100. First-place winner this year was Professor **L. Bryce Andersen** of Lehigh University. The second-place winner was Professor **John A. Roberson** of Washington State University. Their papers appear elsewhere in the JOURNAL.

PUBLICATIONS

Nuclear Technology Briefs are being published from time to time by the Atomic Energy Commission. There briefs report technological progress in such areas as power reactors, reactor materials, spent-fuel processing, etc. Recent issues have covered fuel elements for natural-uranium reactors, aluminum zirconium technology, power reactors, and heavy water production and sales. Copies of the briefs are available from the Industrial Information Branch, Technical Information Service, U. S. Atomic Energy Commission, Washington 25, D. C.

Who Teaches the Teacher?

L. BRYCE ANDERSEN

Department of Chemical Engineering
The Rice Institute
Houston, Texas

Colleges of education are regularly criticized for putting too much emphasis on method and too little on subject matter in their training of secondary school teachers. As a result, critics say, the typical high school teacher may know *how* to teach, but not *what* to teach, especially in the areas of science and mathematics.

An equally valid but ironically inverted criticism can be leveled at college teachers, especially in engineering. That is, the typical young engineering teacher is well-grounded in *what* to teach, but has never learned *how* to teach it. If he chooses engineering education as a career, he takes graduate work in engineering, not education. Upon completion of his graduate work he enters the classroom with no knowledge of teaching methods, except for the examples of good and bad teaching to which he was exposed while he was a student. At the outset he resolves to avoid the errors made by his former teachers and to emulate those teachers who he thought were the best. But after a few months, he begins to realize that the proper teaching of engineering isn't as simple and obvious as it appeared when he was a student. He develops misgivings concerning his methods, and wonders if perhaps some of the vast store of knowledge on educational psychology to be found in colleges of education might not be useful to him.

If he asks his older, more experienced colleagues, he will gain much valuable advice, but he will get the impression that teaching is more or less an art. One can make certain generalizations, but there seems to be little science to the teaching of science. Indeed, his older colleagues seem almost indignant when he suggests that the College of Engineering might learn something from the College of Education. And so, with all of the pressures of his new position, he abandons his efforts to learn how to teach, and serves out his apprenticeship.

But is the current apprenticeship system the most effective method of learning to teach engineering? It is true that all present engineering teachers come up through this system, that they have no formal training in teaching methods; but tradition has seldom led to progress in engineering. A recent amusingly cynical article in the JOURNAL [1] pointed out that while the typical engineering educator agreed that instruction in teaching methods would be good for his colleagues, his methods were quite adequate. Although there was a great deal of talk about methods, there was very little active instruction in the field of engineering education.

The two-day summer school held after the Berkeley ASEE meeting in 1958 was an attempt to formalize instruction in educational methods. This successful session was sponsored by the Educational Methods Division and the Committee for Young Engineering Teachers. But attendance was small. College-sponsored programs would reach a larger number of young engineering teachers.

The Program

Certainly some formal instruction in educational methods would be beneficial for every young engineering teacher. The question really is when can and should such instruction be given. With

First Place YET Paper Contest 1959.

[1] Paré, Eugene G., "For More Effective Teaching," JOURNAL, v. 49, No. 2 (1958).

the very heavy professional course requirements and the limited number of non-technical electives in the typical undergraduate and graduate engineering programs, little time is available for electives in education. Such electives at the undergraduate level are probably undesirable. Few engineering students know as undergraduates that they are going to make teaching a career. The problems of college teaching are perhaps too subtle and complex for even the better undergraduate to consider adequately. The best undergraduate foundation for engineering teaching is probably the typical existing program combining a technical curriculum with a substantial number of liberal arts electives. The future engineering teacher must excel in his English courses as well as in his technical subjects, since teaching requires facility in both oral and written communication. Courses in logic and psychology would also be helpful.

A more formal basic program in teaching methods might begin when the student enters graduate school. Many beginning graduate students serve as part-time instructors or teaching assistants. For those few who are interested in teaching as a career, this part-time teaching serves as a valuable apprenticeship. For the majority who have accepted such positions simply as a means of financial support, teaching is somewhat irrelevant to their career, and the quality of their teaching may suffer because of a lack of motivation. It is quite appropriate for a University to *require* its beginning instructors and teaching assistants to take a formal training program in educational methods. The time required for such courses should be deducted from the assistant's teaching duties. The course might meet two or three hours a week to hear lecturers from the College of Education, the Department of Psychology, and from the more experienced and effective teachers in the Engineering College. Since such courses would be at an elementary level, no graduate credit would be given. The students genuinely interested in teaching as a career could continue to advanced courses for which they would receive minor credit toward their graduate engineering degree. Of course, interested students who were not instructors or assistants would also be eligible for such a program. The basic course, plus six to nine semester hours of additional education courses, would be a reasonable inclusion in the Ph.D. program of a man planning to make teaching a career.

The intelligent reader at this point has probably thought of several objections to such a plan. Of course, it would take time and cost money, but most worthwhile proposals do. The immediate improvement in teaching at the instructor and assistant level would more than justify the expenditure of time and money. Of course, since teaching is a subtle and difficult activity, the improvement might not be immediately evident or of startling magnitude, but it would occur. Many engineering educators recognize that their part-time assistants and instructors are the weakest point in their educational staff. But they consider it inevitable and necessary, since future teachers must start somewhere. The proposed training program would lend some system to this previously casual apprenticeship. Engineering colleges have a responsibility to their undergraduates to see that their part-time instructors and assistants have an adequate foundation in teaching methods.

Engineers who decide later to enter teaching, perhaps toward the end of their graduate work or after several years in industry, should be encouraged to participate in at least the basic program. This encouragement should include a commensurate reduction in teaching load for the first year.

Typical Courses

The success of any such program would depend upon the content of the courses. The experienced engineering educator accustomed to the exact and quantitative thinking of physical science may feel that effective teaching is dependent on such intangible and illusory considerations that formal courses would be a waste of time. Such an attitude ignores the great amount of work done in educational psychology. While edu-

cational psychology is of necessity a less exact science than some fields in engineering, it is no less a science. Teachers of science should not overlook the science of teaching even though it may not be as neatly quantitative as some would require.

Many engineering educators are disillusioned over the activities of Colleges of Education, particularly in regard to teaching of mathematics and physical sciences in the high schools. It is not the purpose here to defend or condemn secondary education. The problems of primary and secondary education are substantially different from those encountered in college education, primarily because of differences in maturity and the concomitant motivational problems. It might be argued that Colleges of Education are preoccupied with primary and secondary education and have given little thought to higher education. While the emphasis may not be on college education, much study has occurred in this area. If a request for formal courses in methods of college teaching were made to the College of Education, they would undoubtedly be able to develop useful courses, in cooperation with the Engineering College. Conversely, since at present there is no demand, few if any such courses exist today.

A look at the graduate bulletin [2] of a large state university reveals several interesting graduate courses in college teaching:

250: *Higher Education in the United States:* Development, present status, and outlook for American Colleges. Purposes of higher education; current and projected programs provided; trends in curriculum, instruction, and administration; evaluation of outcomes.

252: *Effective College Teaching:* Teacher-learning relationship; study and appraisal of methods employed to encourage, guide, and appraise students' learning.

253: *Seminar on Improvement of College Instruction:* For instructors, teaching assistants, and advanced graduate students from various departments of the University and other institutions. Current problems, research, and trends. Offered with the cooperating staff of various teaching departments.

254: *Directed Experience in College Instruction:* An individualized program under guidance of an instructor or department. Emphasizes understandings, procedures, and skills related to application of instructional theory, curriculum development, and evaluation practices. Offered with cooperating staff of various teaching departments.

All of these courses have as their prerequisite one year of graduate study in any field. They are designed to meet the needs of future teachers in any field in the University. The courses are conducted in close cooperation with the student's major department. These are an appropriate selection from one large university. Undoubtedly, other large schools have similar programs.

It is quite possible that the Engineering College would ask for special sections of courses such as those listed above for their major students. The problems of teaching a quantitative science in contrast to one of the humanities would probably make separate sections with a different emphasis desirable. Close cooperation among faculties of both colleges would be essential in the development and operation of the courses. The findings of the Educational Methods Division of ASEE also could be utilized in developing these courses. Not only would the engineering faculty learn about educational methods, but the education faculty might also learn about the methods of physical science. This would aid them in improving secondary-school instruction, to the ultimate benefit of the Engineering College.

In addition to courses such as those listed above, others in the psychology of learning and of motivation at the college level would be useful. These courses are usually available in the Psychology Department.

[2] Bulletin of the University of Minnesota Graduate School.

A formal program such as that outlined above would be a major step toward improvement of teaching in engineering colleges. In addition, a more informal seminar would be a useful adjunct to such a program. The seminar would be a free-wheeling "bull-session" on teaching, attended by the younger engineering teachers, both part-time and full-time. While attendance at such sessions would be encouraged by the Dean and department heads, participation would be voluntary. The seminar would be run by the younger teachers themselves. They would choose their subjects and on occasion call in an older staff member from engineering, education, or psychology, for facts and advice. In such an informal seminar the novice teachers could thresh out problems which have arisen in their teaching. The seminar might meet for one hour each week. It would have official sanction, and it might be developed by the Educational Methods Division and YET, and operated by the local YET Chapter.

The informal seminars could on occasion be useful in introducing the teaching profession to interested undergraduate and graduate students. When the subject was appropriate, students who were considering teaching as a career would be invited to participate. With proper publicity, such sessions could be useful in the development of an interest in teaching, particularly among undergraduates. As a group, undergraduates seem reticent about discussing their interest in teaching with their teachers, perhaps because they don't wish to ap pear presumptuous. This informal se inar with younger faculty members wou give the undergraduates a chance learn about the profession in a relaxe atmosphere.

Engineering educators teach their st dents that high efficiency is a desirab characteristic of any process. Even small improvement in efficiency can ma a process economically much more a tractive. With the present ever-increa ing quantity of material to cover in t typical engineering curriculum, any sm increase in the efficiency of teachi would be highly desirable. An ineffe tive teacher is extremely inefficient. one hour in class he can so obfuscate t fundamental issue that each student m spend several hours outside straighteni things out in his mind. On the oth hand, an effective teacher who is famil with efficient educational methods c clarify the problems and thereby save great deal of student time. The ti gained by this educational efficien could be devoted to obtaining an i creased understanding of the subject.

One of the most important areas in t development of engineering faculties the improvement of engineering teac ing. That the engineering colleges ha made great strides in the teaching of e gineering is undeniable. However, so of the methods employed in the traini of teachers appear to be inefficient a ineffective. It is time to rely more the science of teaching in the teachi of science.

COMPUTER APPLICATIONS SYMPOSIUM

Proceedings of the 1958 Computer Applications Symposium, held last Oct. 29 and 30, are now available. Priced at $3 a copy, the publication includes 14 papers presented at the conference, plus transcripts of panel discussions at the conclusion of each day's technical sessions. Orders for copies should be addressed to Armour Research Foundation, Main Files: CA-5, 10 W. 35th St., Chicago 16, Ill.

The 1959 Computer Applications Symposium, the sixth in a series, will be held on Oct. 28 and 29 at the Morrison Hotel, Chicago. The conference is sponsored by the Foundation.

Teaching Efficiency and Class Size

JOHN A. ROBERSON

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Increased enrollment in our colleges and universities will produce major problems unless substantial changes are made to alleviate the situation. At the present time, our grade schools and high schools are bulging at the seams with students who will shortly be entering institutions of higher learning. It has been estimated that within ten or twelve years, universities and colleges will be faced with the problem of accommodating about twice as many students as are presently enrolled[1]. Furthermore, it is fairly well accepted by most teachers and administrators that if good teachers are to be retained, their salaries must be comparable to positions of similar responsibility in industry, and their work loads must be kept to a reasonable level.

In contrast, it is the policy of a number of university administrations to restrict the procurement of additional teachers even though the enrollment is increasing. In other words, many universities are not planning to increase the number of faculty members in the same proportion as student enrollment increases. Economy is their by-word.

Drastic steps *could* be taken to eliminate the problem. For instance, the entrance requirements could be periodically adjusted so that the number of students allowed to enter our universities is held fairly constant; however, in the case of the state supported universities, this method may be short-lived. If the enrollment is allowed to increase without a proportionate increase in numbers of teachers, then it must be concluded that it will be necessary for the teacher to become either more efficient, or to just do more work.

At Washington State College, the administration from the president down to the department heads are keenly aware of the situation that is now beginning to confront them with respect to enrollment vs. teaching loads. Steps are continually being taken to promote more efficient teaching methods, and one main experiment under current study involves large classes.

Under the direction and instigation of Professor E. B. Moore, Chairman of the Department of Civil Engineering, sixty-man sections of Engineering Mechanics and Mechanics of Materials are being taught and with very good success. The author had the pleasure of teaching a large section of Mechanics of Materials in the fall semester, 1958, and again in the spring of 1959.

With the foregoing as an introduction, the main part of this paper will be devoted to a discussion of the experiment in teaching large sections in engineering. This discussion will be presented under the headings: (1) Background, (2) Procedures Used, and (3) Results.

Background

For years, many schools have given large classes in the social sciences, humanities, chemistry, and physics; but it has been the opinion of many engineering educators that classes larger than 20 or 25 are not feasible for engineering. Some have said that the personal contact would be lost and others have said that there would not be the opportunity for

[1] Du Bridge, Lee A., President, California Institute of Technology, "The Best is None Too Good," JOURNAL, Vol. 49, Jan., 1959.

Second Place YET Paper Contest 1959.

exchange of information between the instructor and student by way of questions and answers. This opinion and policy among most engineering schools has persisted throughout the history of the U. S. Recently, however, a trend toward larger classes in engineering has been developing. Several schools have been experimenting with large class size in their Engineering Mechanics and/or their Mechanics of Materials courses.

At Rensselaer Polytechnic Institute, an experiment was conducted to determine the degree of "Student Achievement as Affected by Teaching Method and Class Size [2]." Their large classes in mechanics had over 80 students enrolled in each. One of Rensselaer's conclusions, based upon a carefully controlled study, was that "student achievement varies as a function of the *course instructor*, and *not* as a function of class size." The report, published by Rensselaer, was very instrumental in arousing the interest of the civil engineering faculty at Washington State College.

Another report describing an experiment in large classes for engineers at the University of Kansas shows that students do just as well in large classes of statics as students in smaller classes [3].

Procedures Used at W.S.C.

With Rensselaer's document as a guide, members of the Civil Engineering Department at W.S.C. proceeded in the spring of 1958 to plan for large classes in Mechanics and Mechanics of Materials to be taught during the 1958–59 school year. The plan adopted was essentially that which was used by Rensselaer in their studies. During the summer, two members of the department prepared special manuals. For each course, a student manual and instructor manual were prepared. The student manual stated the general policies of th course and outlined day by day th course content and daily assignments be covered. For each lecture period, th manual summarized the important poin of the lesson and supplemented the te whenever necessary. The instructo manual included brief suggestions to th instructor concerning each lesson.

The course sequence was planned that somewhat formal lecture sessio were presented every other day wh ten-minute quizzes followed by an info mal discussion session were given on a ternate days. Daily problem sets we also assigned to the students and they r tained the problem sets in a noteboo which was then periodically review and graded.

The schedule allowed for six one-ho exams and a three-hour final exam. A though each instructor followed qui closely the schedule as set down in th manual, the individual instructor was his own with respect to quizzes, ho exams, and lecture presentation. Mo of the instructors used single proble type short quizzes where part credit w allowed for partially correct solution however, the author preferred to use mu tiple choice type problems where part credit was allowed.

During the planning stage, som thought was given to a course sequen whereby a senior member of the facul might give the formal lectures while th junior members or graduate studen would conduct the short quiz and i formal discussion periods in small group This method was rejected, however, b cause it was felt that a certain amount discontinuity might result by having tw faculty members involved. Also, it w felt that smaller groups for the discussio periods would defeat, in part, the pu pose of the experiment.

It was anticipated that more tim would be needed for the careful prepar tion of lectures for the large class and correct the greater volume of papers, 1½ credit hours were allowed for ea contact hour in the large sections. I other words, for teaching the four-seme ter-hour Mechanics of Materials cours

[2] Trathen, Roland H., Assoc. Head, Department of Mechanics, "A Study of Student Achievement as Affected by Teaching Method and Class Size," Rensselaer Polytechnic Institute, Troy, New York (1957).

[3] Deemer, Kenneth C., University of Kansas, "Larger Classes—One Answer to Increasing Enrollments," presented at ASEE meeting in Berkeley, California (1958).

TABLE 1

STUDENT OPINIONNAIRE ON THE LARGE MECHANICS CLASS METHOD

In order to determine students' reaction to the procedures used in connection with large classes in mechanics, you are asked to answer the questions below. Circle only one answer per question. If you feel the procedures were very effective, circle the letter A. If they were very ineffective, circle F, etc.

Do not sign your name at the end. If you have comments, they may be added at the place indicated.

The papers will be collected by a designated person, and sealed. The instructor will not see the results until after semester grades have been turned in.

1. How effective was the instruction manual?

(23%)	(61%)	(15%)	(1%)	
A	B	C	D	F

2. How effective was the class of this size in requiring you to reason and think?

(13%)	(52%)	(32%)	(3%)	
A	B	C	D	F

3. How effective were the instructional procedures used? These include instructional manual, formal lecture, short quizzes, and discussion.

(53%)	(36%)	(11%)		
A	B	C	D	F

4. How effective do you consider the short quiz method in contrast to handing in daily work?

(58%)	(26%)	(8%)	(8%)	
A	B	C	D	F

5. How effective were the student-instructor relations in the class?

(43%)	(45%)	(10%)	(2%)	
A	B	C	D	F

6. How do you think a large class compares with engineering classes of 20 to 30 so far as your learning the material is concerned? Mark one space below.

(13%) a. Better than smaller classes.

(72%) b. Equal to smaller classes.

(15%) c. Poorer than smaller classes.

7. Comments, if any:

an instructor received six semester hours of credit.

Results

The results of the experiment were evaluated both by seeking the opinions of the instructors involved and by polling the students to get their reaction to the class size and procedures used.

Instructor's Views: During the first semester, it was my personal feeling that it took about a month to feel "at home" with the class, and then it seemed that the handling of the large section was no more difficult so far as lecture presentation was concerned than a small class. It should also be noted that the text was new to me, so that a certain amount of uneasiness may have been due to getting acquainted with the text. This second semester, I felt completely confident with the class right from the start.

Since formal lectures were given only every other day, these lectures had to be planned very carefully in order that the material could be covered. The ten-minute quizzes took extra time to prepare; but where multiple choice quizzes were used, the grading time was quite short. Grading of hour exams was very

time-consuming, so that the extra credit given for the large class was obviously needed.

When planning the course sequence, it was thought by some instructors that there would not be enough time after the ten-minute quiz for questions and answers. In my case, we usually had ample time to answer all questions, and upon several occasions the class was dismissed early on the quiz-discussion day.

Prior to this experiment, there was some doubt as to whether the instructor would get to know the students in the class. By the end of the semester, I could recognize every man by name. I could comment on some of their personality traits when asked to write letters of recommendation. I personally corrected all quizzes and hour exams and made an effort to hand back all hour exams to each man in person. Several other instructors said that they never did know the men in the class well enough to recognize them by name.

So far as effectiveness was concerned, I believe that my examinations were as rigorous, or perhaps even more so, as I had given in the past; and students seemed to have no more difficulty than students in smaller classes. It is my opinion, and this was shared by all faculty members participating in the experiment, that the large classes were handled just as effectively as small classes.

Student's opinion: Many of us at W.S.C. feel that the student evaluation of course procedure or of teaching effectiveness is the truest appraisal that one can obtain. With this thought in mind, a "Student Opinionnaire on the Large Class Method" was completed by the students several days prior to the close of the semester. A sample "Opinionnaire" with the tabulated results for Mechanics of Materials classes is presented in Table 1.

The numbers above each letter of the opinionnaire indicate the percentage of students marking that particular choice. It may be noted that in almost all cases, the mean value falls near the "B" or "B+" grade. This seemed to be fairly universal for all classes. Results for question number six concerning comparison of a large class with small classes are very significant. In the Mechanics of Materials classes, 72% thought that the large class was as effective as smaller classes, while 15% thought it was poorer than smaller classes, and 13% thought it was better.

Some students wrote comments, and a few that seemed to convey a significant opinion will be discussed. First, some commented that the large class influenced their decision to ask questions. Several thought that they would have asked more questions if the class had been smaller, while one man said that he never asked questions anyway, so it didn't make any difference. One man made a statement which seems very significant: "A large class is fine *if* a good text is used. This class had a good text, so no trouble. But if it is attempted in other courses, for heaven's sakes listen to the students' comments regarding the text."

Conclusions

Based upon results of experiments in large classes at this institution and supplemented by similar experiments at Rensselaer and Kansas, it is concluded that large classes (at least to 60 students) in Mechanics and Mechanics of Materials can be taught just as effectively as small classes. It may also be concluded that it would be possible to double a teacher's efficiency by teaching large classes. For example, if a 10-hour load is taken as normal, then a man teaching classes of 20 students per class would teach 10 (credit hours) $\times$ 20 (students) = 200 student credit hours, while a faculty member teaching classes of 60 students would handle $\frac{10 \text{ hrs.}}{1.5 \text{ hrs./cr.hr.}} \times 60$ students = 400 student credit hours.

By giving increased credit for the large class, the instructor has the opportunity to devote more time to preparation. He can study various ways of presenting material, as well as the theory of the subject. This results in the important secondary benefit. The instructor completes the course with a definite sense of satisfaction of having done a good job.

Planning a Good Professional Meeting

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This article is intended to give some specific suggestions that are not commonly encountered for arranging and conducting professional meetings. It is the result partly of the author's own experience, but reflects many ideas received from others. The help of all those who took the trouble to write, or who discussed the subject, is gratefully acknowledged.

Organization

It seems trite to note the importance of prior preparation for a successful meeting. Yet the effects of late planning are sometimes only too evident in second-choice speake..., inconvenient accommodations, uncoordinated program, and general confusion. Housing, eating places, and meeting rooms should be tentatively reserved, and committee chairmen appointed, as soon as it is known that the meeting will be held.

Chairmen should realize that their duty is to inspire and organize, not to do all the work. The aim should be to have every faculty member of the host school on a committee, both to lighten each individual's load and to promote wide participation. It is difficult to create a good meeting spirit when only part of the local faculty attend. Most professors will not deliberately avoid the meeting, but are so busy with other activities that they must be personally approached if they are to realize the importance of their participation.

If the chairman takes the time to make a detailed schedule of each person's or group's duties, taking care that there is no omission or duplication, he will probably find that he has little more to do than watch the organization run. If he does not make such a schedule, he will probably spend his time dashing about meeting successive crises. Each committee and committee member should work as autonomously as possible. If each member's responsibilities are clearly designated, a committee can be very successful without ever holding a meeting. Any meetings should be devoted to general policy and ideas, not to debating details.

Arrangements

One immediate question is financing. There are various procedures, such as donations from the host school or its faculty, "padding" of meal prices, or charging a registration fee. If money is needed, the last seems to be the best procedure, as few will object to paying the actual cost of a good meeting, but many will remark a discrepancy between a meal and its cost.

An even more difficult question is estimating attendance, especially at meals. As far as possible, there should be preregistration, obtained by good publicity and by sending a preregistration form to every person. However, preregistration figures may still bear little resemblance to actual attendance. Questionnaires for trying to ascertain people's tentative plans are of doubtful value. Many persons will change their minds or ignore questionnaires. Further confusion is caused by those who, having returned a questionnaire, believe they have reserved a place and therefore do not preregister.

Too much publicity is unlikely. An early announcement to be posted at the various schools should be followed by one or even two individual mailings. A few well-placed personal letters can be most helpful in gaining publicity help at each school.

Preregistration blanks must be carefully designed. If a misinterpretation is

conceivable, it will occur. The hosts should also give prior consideration to how the returned blanks will be handled, to avoid the necessity for copying parts of them or tearing them in pieces for the various committees' use.

The impression visitors get on arrival depends on registration arrangements. At some meetings, the hosts seem surprised that guests have appeared. This contrasts with the procedure whereby each preregistrant is simply handed a personal envelope containing all material (with the amount due for fees and tickets previously computed and noted), and his payment collected. There is then ample time for answering questions and otherwise making the guests feel welcome. The ladies may add to the hospitality by serving coffee at the registration center. It is also helpful to keep the registration desk open as much as possible, because people will come for information at almost any time of day or night. Each visitor may be given a list of preregistrants, arranged by field of interest, to help him contact those teaching similar subjects at other schools.

Careful account must be kept of reservations and tickets sold for meals. A single irregularity, such as a block of tickets reserved by a single person for several unnamed individuals, can create tremendous confusion by making it impossible to predict attendance. Instructions to the caterer should go through only one man. It may be convenient to use a different colored ticket for each meal.

Most of the arrangements will be well made if the guest's point of view is considered. This applies to parking, signs, providing maps and other information, supplying transportation, and housing. Depending on circumstances, the housing committee may make all reservations, or it may provide an informative list of accommodations for the guests to make their own reservations.

The appropriate office should be consulted regarding school regulations for meetings, and the requirements followed. Occasionally a rule will appear to prohibit a desirable arrangement, but if the problem is explained to the proper person a modification may be made. Personal contact is most important here.

Program Suggestions

The technical program is naturally considered to be the core of the meeting. The planning committee should not forget, however, that people come to compare ideas, and not merely to sit and hear papers which they might more efficiently have read at home. Therefore, the program should provide a maximum amount of discussion, rather than being built around a perhaps disjointed series of formal papers. Much to be preferred are informal panel sessions, with each speaker limited to a few minutes, followed by questions and comments from the floor. To be successful, this requires that each panel member be clearly briefed as to his role—before he has prepared a speech! Only too familiar is the meeting with elaborate specifications for how discussion will be conducted, but where no time actually remains after the speeches are concluded.

A more stimulating exchange of ideas results from controversial subjects rather than from areas of general agreement. Panel members should represent various points of view, including industry, and they should not be afraid to express themselves. General meeting subjects should be of interest to all engineering educators, but since there are many problems peculiar to certain branches of engineering, ample provision should be made for the various branches to meet separately.

Distinguished educators, younger men proving themselves, and leading undergraduate students can offer interesting comments, particularly on a topic involving teaching methods. A stimulating exchange of ideas, rather than forming a conclusion, should usually be the goal. Someone placed in the audience to express a contrary view can start a lively and genuine discussion.

Occasionally it seems desirable to try to reach some definite conclusions. The discussion may then be led by a "source person," similar to the position of the teacher during a class discussion. Or a large assembly may discuss a subject in

small groups, followed by an oral report from a spokesman for each group.

A variety of approaches is good. The skit, with the parts either acted or merely read, was effectively employed at the ASEE national meeting in Berkeley. Similar to this is the demonstration, such as a discussion of closed circuit TV being presented via the same. A talk may be made more realistic if the speaker generously illustrates with case studies.

Often a stimulating conversation at luncheon or dinner is interrupted by the announcement that there will now be a speech. This experience suggested the "common interest luncheon." Each preregistrant is asked to indicate his fields of interest (such as control systems), within his major field (such as electrical engineering). The host school then prepares a seating plan for the luncheon, so that each person is seated at a table of six or eight with others of similar interests, and is not sitting adjacent to a person from his own school. Each man finds his table by the table number written on his ticket, and his chair by a place card. There are no speeches or other formal program at the luncheon, and at least two hours is allowed before the next event. This requires some effort by the hosts, but results in contacts that would otherwise not occur, especially for people who are inclined to stay with known friends rather than risking the unknown.

A very hospitable event is the opening of certain host professors' homes for an evening. The hosts are introduced, and an opportunity provided for each person to approach the professor he would most like to visit and make arrangements for transportation to his home. The resulting gathering of several people at each home can be very enjoyable as well as instructive. An alternate method is to have the information at the registration desk, where each registrant signs up to visit the host of his choice.

Seeing the campus, particularly the laboratories and other teaching facilities, is also of interest. However, rather than be given a quick and perhaps tiring tour of the complete plant, most visitors would prefer a detailed examination of a few places concerning their own special fields. This wish can be satisfied by a laboratory open house, with staff members present to discuss and explain. Elaborate exhibits need not be prepared. The visitors should be given a list of laboratories, their locations, and names of host professors in attendance.

Simplest, but not least important, is merely providing ample free time between events. To many people, the most valuable part of the meeting is the discussion carried on in hallways and lounges. It may be possible to arrange a very pleasant atmosphere for these discussions by scheduling an event such as a leisurely boat trip or an outdoor barbecue.

And there should be "breaks" in any meeting lasting over an hour. Sometimes the chairman fails to call a break because he fears that people will leave! It is hoped that some of the ideas presented here will suggest other less direct but equally effective means of holding people—and their interest.

Many topics, such as the value of plant tours, the importance of extending an early invitation to obtain a really excellent principal speaker, providing adequate visual aids wherever appropriate, arranging a good ladies program, and the admonition that papers not be read, have been omitted. This is because they are relatively obvious, or are discussed elsewhere. (Regarding the reading of papers, see "Reading, Rudeness, and Redundancy," by Hiram Brown in the April 1958 JOURNAL, and "So You're Reading a Paper," by Harold Haskitt in the January 1957 JOURNAL.)

One of the most important tasks, and one least likely to be accomplished, remains after the meeting. This is the writing of a report by each committee chairman, to be assembled with other documents and a report by the general chairman. If, by great resolve, this is done, the committees for the next meeting will be saved many trials of guessing and rediscovery. And one of these committee members may be you!

Organized Help for High School Science Teachers

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For self-evident reasons, professional societies are eager to increase the supply of well trained scientists, engineers, technicians, and even laymen. And so they appoint Education Committees and tell them that one of their principal functions is cooperation with and help for high school science teachers. But the committees are rarely told exactly what they are to do or whom they are to help. They often don't even know what they *can* do. Each committee goes its own fumbling way; in metropolitan areas, more than a dozen can cross each other's paths unknowingly. Some high school teachers never know of the existence of the committees; others are swamped by overlapping or misguided efforts to be helpful.

That kind of confusion and inefficiency existed in the Dayton metropolitan area until the inception and execution of the plan we are going to describe now.

The Dayton Plan

Our first step was tentative and exploratory, of course. We talked informally with colleagues and acquaintances in other societies to find out whether they had the same general aims and faced the same problems and whether they thought our plan for a Council of Education Committees would be acceptable and feasible.

Getting the right answers, several of us, including a high school science teacher, formed an ad hoc committee to put the plan into operation. We sent a letter to all the professional societies we know of in the area (the Chamber of Commerce can usually supply a list). In the letter we explained 1) the need for organizing and integrating the efforts of the societies on behalf of high school science teachers; 2) the intention to coordinate but not to abridge the work of the individual societies; 3) the need to have a delegate from each society who was authorized to speak for his group.

We got a very good response and proceeded through a series of organizational and path-finding meetings. We had some interesting discussions trying to define our objectives and methods in terms of what the science teachers wanted and what the societies had been doing or wanted to do. The results will be summarized later.

After this groundwork was laid, we took our ideas to the school boards (in the beginning we did not go to the suburban school districts because we did not know how much we could do). The school boards were enthusiastic and promised their support.

Then, to publicize the Council, we prepared a simple brochure explaining our reason for being, listing the sponsoring societies, listing the services we are prepared to offer, and telling how these services can be obtained. We sent to each school's administrative office enough copies of the brochure to allow every science teacher to be given one.

With each brochure we enclosed a stamped post card addressed to the Council. We asked each teacher interested in obtaining one or more services from the Council to state on the post card his name, his position, and the subjects he teaches. These cards formed a registration file and mailing list for the Coun-

cil, and in return we sent each respondent a list of the individuals responsible for coordinating the several services. Thereafter, each teacher could call directly the person who could help him with a particular problem. These lists are revised periodically and each list is effective only until a specified expiration date, since the coordinators change pretty often.

While these promotional activities were going on, each Council member went back to his society with our list of services and canvassed the members for volunteers—people who could speak, for example, or judge science fair entries or contribute technical literature. The size of the convassing job varied, naturally: the I.R.E. representative sent out 600 questionnaires and catalogued the replies on punch cards; another man talked personally with everyone in his small group. But the result is a reasonably thorough compilation of the local talent and facilities available to science teachers.

To get this information out to them, and incidentally to remind them periodically of our existence, we send out a simple newsletter which describes in some detail our resources in one of the nine service areas. We print these newsletters on three-hole notebook paper and suggest that they be filed as a catalogue to our services.

Those services we finally agreed upon are as follows: 1) arrangements and plans for tours; 2) career guidance; 3) distribution of technical literature; 4) loans of technical equipment; 5) loans of technical films; 6) professional technical assistance; 7) scholarship information; 8) science fair judges; and 9) speakers.

We have received fine cooperation from the thirteen local sponsoring societies: ACS, AIEE, ARS, ASCE, ASEE, ASME, ASM, IAS, IRE, Ohio Science Education Association, Optical Society of America, Society of Professional Engineers, and Society of Technical Writers and Editors.

We feel that we are making a significant contribution to local science education: we have located and tapped nearly all sources of assistance, we have centralized and classified them, we have established clear, simplified two-way communications between the teacher and his willing benefactors. We know what we are prepared to do, and—equally important—the teacher knows it, too. He has all the resources in the area at the end of his telephone line.

If you are on an Education Committee—or even if you're not—perhaps you'll find this idea provocative. If there aren't many active professional societies in your city, perhaps there are public-spirited industries stumbling over each other trying to help. If there are neither active societies nor industries, then perhaps the different schools and departments in your university are frequently asked for assistance. In any of these situations a plan like this one would be appropriate and helpful.

In fact, Dean Elmer C. Easton, Vice President for Instructional Divisions, has suggested in a letter to ASEE Divisional Chairmen that a similar plan on a larger scale might be a worthwhile project for the whole Society. Giving credit to former ASEE Treasurer John Gammell for the idea, Dean Easton endorses it enthusiastically and says that if ASEE could coordinate the efforts of other societies' Education Committees, it would be performing a great service.

NATIONAL SCIENCE FOUNDATION MAKES 1006 GRANTS IN SUPPORT OF SCIENCE

The National Science Foundation made 1,006 grants totaling $45,572,385 during the second quarter of fiscal year 1959. Grants were made for support of basic research investigations, conferences in the sciences, exchange of scientific information, and institutes for science teacher training. Forty eight of the 1,006 grants were in engineering.

A Doctoral Program for the Small Engineering College

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Summary

While there is widespread concern over the prospective increases in undergraduate enrollments during the next few years, relatively little has been suggested to augment the number of students working toward the engineering doctorate. A number of the smaller engineering schools currently offer curricula leading to the doctor's degree. It is recommended that more of the small engineering colleges undertake doctoral programs. A plan is suggested for effecting this in terms of faculty, students, research facilities, and administrative policies.

Introduction

Over the past half-century many American universities have offered the doctor's degree in engineering as a reward for performance in course work, the defense of a dissertation, and the completion of certain other statutory requirements. In general, the engineers have followed the pattern already established in the physical sciences, with major and minor areas of study, foreign language requirements, and oral and written examinations.

Until recently, however, only a small number of engineers pursued graduate study through the doctorate. This was due in part to the limited opportunities for support during the graduate years, and in part to the apprenticeship traditions of the engineering profession. The great increase in doctoral enrollments came after World War II, as a result of an increased interest in engineering science and with the added stimulus of the "G.I. Bill."

Currently about 600 engineering doctorates are awarded each year. While this may seem low for a nation as large as the United States, it represents an increase of roughly 6 : 1 over the immediate pre-war years. From industry, government, and the universities, there is a great and growing demand for men with the doctor's degree in engineering. It is the purpose of this paper to discover how the small engineering college may help to fill this need.

The Small Engineering College

Some definition must be given for the small engineering college. If this is fixed at a maximum undergraduate enrollment of 600 men, then roughly one-third of the accredited engineering colleges in the United States can be listed in this category. The distribution of these engineering schools between universities and technological institutes is about in the ratio of 5 : 1.

Among professional educators there has always been strong support for the small engineering college. This sentiment has also been echoed by the alumni and by the personnel officers of many important industrial organizations. The foremost reason advanced in support of this stand has been the closer ties between students and faculty. In general, classes are smaller, and the students may recite more often. Even with less laboratory equipment, the laboratory instruction may be more effective. The close cooperation between staff and students and the fact that the students know one another help to impart a sense of "belonging." The department heads are closer to the day-to-day problems of instruction, and better departmental operation is possible. The dean has an oppor-

tunity to make his leadership felt amongst the students as well as in the faculty. All these and many more advantages may be claimed for the small undergraduate engineering college. Within the limits of geography, educational budgets, and personalities, a greater or lesser number of these claims are realized.

Superficially it might appear that small engineering schools would be limited to undergraduate instruction. However, this is not the case, for there are programs at both the master's and the doctor's levels in many of these institutions.

Of some 55 colleges in this group, about 76% have students working toward the master's degree; 38% have what might be called "large" masters' programs. In some of the urban institutions there are more men working for the master's degree than for the undergraduate degree.

In general, the national trend in the requirements for the masters' degrees in engineering has been reflected in those of the small colleges. Fewer institutions require the master's essay; additional courses or special problem work have supplanted it. Where a thesis is still required, publication is not mandatory. As a result, students are able to work productively in very small areas of particular interest to faculty sponsors, a situation that is often mutually beneficial. The increased demands of industry, government agencies, and the educational field, for men with graduate degrees, have raised the graduate enrollments over the nation. In round numbers, the awards of the master's degree stand at about 5:1 over the pre-war level. Yet more than 15% of these masters' degrees are being earned in the small colleges.

Of the group investigated, about 25% offer programs leading to the doctorate; about 14% have large doctoral enrollments. At first glance these figures are surprising. One usually thinks of doctoral programs in terms of the staff and resources of large universities. However, about 15% of the engineering doctorates are earned in the small colleges, and some very fine research work has been described in the dissertations. With some advanced planning and some intercollegiate cooperation, sound doctoral programs could be established in many more of the small engineering colleges.

The Engineering Doctorate

In discussing the engineering doctorate it is instructive to recall the practice in old Germany, where the student went from one seat of learning to another in search of the leaders in his field. Finally he stood for examinations and defended a dissertation, but his "course work" was spread over many institutions.

While it is neither possible nor desirable to adopt the old German system, it does furnish some important reminders as to what is significant in the training of Ph.D. candidates. As the doctorate is the highest earned degree, it should be conferred only upon those who have shown good academic performance and who clearly have the potential to make contributions in a given field. As the prized hallmark of the institution, the doctorate must reflect the best efforts of the faculty and staff as well as those of the candidate. Therefore the establishment of a doctoral curriculum involves the college in a heavy ethical and moral commitment.

There are wide variations in the requirements for the doctor's degree in engineering. Significant differences may be found between the departments within an institution. However, it is rare for a student to complete the doctorate in less than three years after the baccalaurate. There are qualifying examinations, foreign language reading examinations, prescribed course work, preliminary examinations, and research work to be embodied in a dissertation which must be publishable and orally defended. Due largely to the system of language options available in the secondary schools, and to the tendency of the students to select the easiest path, many men are deficient in scientific language reading ability in college. As a result, a surprising amount of time is consumed in learning enough of the required foreign languages to meet the statutory reading requirements. In terms of student time and money, learning modern languages at the postgraduate scientific stage is certainly wasteful.

Surprisingly enough, many schools have liberal policies on the research work embodied in the dissertation. This work may constitute some phase of a large sponsored research project at the university. It may be work done in a government laboratory, or in an industrial laboratory, in absentia. In some cases the work is done in another department of the university. There is a broad spectrum of practical arrangements that has been used to gain access to the equipment and apparatus necessary for meaningful results in engineering research.

Although it is implied rather than stated in most university catalogs, the character as well as the abilities of the candidate should be attested to in the awarding of the doctorate. These traits are revealed to the faculty and research staff as a result of close contact over a reasonably long period of time. For such contact to be possible, there must be a limitation on the number of students assigned to a given professor. Therefore large doctoral programs require proportionately large staffs of people competent to direct such work.

The great monolithic roadblock on the way to the doctor's degree is the rigid interpretation of the course work requirements. Generally, there is little or no acceptance of transfer credits for work done previously at other institutions. In addition, there may be formal residence requirements to be met. Liberalizing influences are at work on both the course and residence requirements, but there is still a great distance to go. The cost of maintaining a large staff of competent teachers for the advanced courses has been a major deterrent to the doctoral aspirations of many of the small engineering colleges.

What Might Be Done

(1) Our universities and technological institutes, regardless of size, should undertake a re-examination of their doctoral requirements to determine what is meaningful and what is academic nonsense. Time needlessly lost in the graduate years is time tragically wasted.

(2) Faculty members in the small engineering colleges should seek out those undergraduate students with the potential for advanced work. These young men should be encouraged to plan for graduate study, and particularly to make up language deficiencies.

(3) As the small college cannot embark upon programs involving extensive offerings of graduate courses, a "core" or minimum group of courses might be required at the parent college.

(4) Students should be encouraged to take specialized courses wherever such courses are available, during the regular terms and/or summer terms. As a matter of record, the transcripts for courses taken off campus should be filed with the faculty advisor. However, the thought of accumulating "course credits" at the doctoral level is inimical to the quality of education that is sought. It is good for the student to see at first hand the methods and techniques at other institutions, and in the urban areas there are great opportunities for such educational sampling. In a sense, this would approximate the old German scheme.

(5) Where courses are taken at a number of institutions there must be careful planning by the faculty advisors to ensure that the student has the appropriate coverage of subjects. Preliminary examinations would have to be correspondingly comprehensive, and might extend over a longer period of time than is currently common.

(6) To satisfy the administrative officers that high quality doctoral preparation has been made, external examiners could be invited for both the written and oral parts of the preliminary examination. These external examiners could be given a small honorarium, or they might be exchanged on some regular basis between colleges.

(7) As the doctorate is a research degree, considerable use can be made of th auxiliary departments in mathematics and the pure sciences.

(8) In addition to formal classroom courses, doctoral programs may include a generous number of reading courses. In these reading courses, under the loose supervision of an experienced professor, the student develops his ability to do

library research, and increases his self-reliance in technical fields.

(9) In the small college the areas in which the doctorate may be earned must be restricted in terms of staff and facilities. It might be appropriate to offer the degree in only one department, and perhaps in only a few of the special fields of the department. There is no glory in being semi-successful, and even the largest universities restrict the areas for doctoral work to those for which they are especially equipped.

(10) It is a commonplace to say that it is the duty of an institution of higher education to learn as well as to teach. Within reasonable limits this should also be the goal of the small engineering school.

(11) Careful planning by staff and students will make it possible to build several doctoral research projects around the same equipment, effecting savings in instrumentation.

(12) Sometimes it is possible to develop equipment for a thesis which can be used later for undergraduate instruction. This helps to justify the original expenditure.

(13) In a small college the faculty will find it stimulating to work with doctoral aspirants in both classroom and laboratory.

(14) Knowing the limitations that must be imposed in a particular research project, can enough original information be obtained to support a dissertation? Particular pains should be taken to anticipate such a situation by a very careful preliminary analysis of the problem. The small college might be particularly vulnerable to this type of difficulty, and must make every effort to guard against it.

(15) It is particularly helpful when thesis research work can be done as a part of a large continuing research project, whether sponsored by the institution or by an outside agency. This device is coming into wider use, and could be scaled to the needs of a small college.

(16) As the need increases for men with the doctorate in engineering, more forms of sponsorship will become available. Industry is currently offering many types of tuition refund plans, and a number of companies will support a graduate student through the Ph.D. degree. Special arrangements are available for certain employees of the federal government for leaves-of-absence and financial aid. The help of the small engineering colleges in meeting these needs of industry and of government could be significant.

(17) There is a growing need for men who can carry a reasonable amount of teaching responsibilities while earning a degree. The small college can be tremendously helpful here in the development of the younger men who will have to be educated simultaneously as teachers and as research workers. This is one of the avenues which must be kept open if we are to keep even a fraction of the Ph.D.'s in the teaching profession.

Conclusions

(1) To meet the growing demands of the teaching profession, industry, and government for men with the doctorate in engineering, small engineering colleges should be encouraged to expand current doctoral programs and to initiate new ones.

(2) The small engineering college can make a significant contribution within the limitations of staff and equipment, for currently about 15% of the engineering doctorates are earned in such institutions.

(3) A liberalization of the doctoral course requirements would be extremely helpful to the smaller engineering college, and need not be done at the expense of standards. More extensive use could be made of reading courses.

(4) External examiners for both written and oral preliminary examinations might be helpful in establishing standards of performance that would be widely accepted.

(5) To protect both the student and the institution, an advisory committee should pass upon the topic and scope of the dissertation. External specialists might be invited to meet with the advisory committee.

(6) Only the highest quality work should be acceptable at the doctor's level. Doctoral programs must be limited to

those departments with adequate staff and equipment.

(7) The size of a department can not be a determining factor in the question of whether or not a doctoral program should be attempted. It often happens that a small but well-knit department is best suited for such a venture. The necessary ingredients are imagination, energy, persistence, and sound planning.

Acknowledgments

A draft of this paper was read by Dean Harold L. Hazen of the Massachusetts Institute of Technology, and by Professor Newman A. Hall of Yale University. The author wishes to thank these gentlemen for contributing their critical suggestions, several of which have been incorporated in the final draft.

Each of the reviewers expressed doubt as to the value of the external examiners, particularly in view of the complicated mechanics of doctoral examinations. Neither of them would welcome a burgeoning of doctoral programs merely to satisfy numbers. Each was emphatic in stating that the value of a doctoral program is measurable in terms of the intellectual integrity and vigor of the faculty members involved.

NEW DEAN OF ENGINEERING AT PRATT INSTITUTE

Dr. Roy H. Cook has been appointed Dean of Pratt Institute's School of Engineering, Dr. Robert Fisher Oxnam, President of the Institute, has announced. The appointment became effective March 1, 1959. Dr. Cook has been Chairman of the Departments of Mathematics and Physics in the Engineering School at Pratt since 1957. Before joining the faculty at the Institute, Dr. Cook was Manager of the Engineering Divisions of the Armament Department of White-Rodgers Co., St. Louis, Mo.

Dean Cook replaces Dr. Warren E. Wilson, who recently resigned to accept a post at Harvey Mudd College, Claremont, California.

NATIONAL SCIENCE FOUNDATION MAKES 377 GRANTS IN SUPPORT OF SCIENCE

The National Science Foundation has announced 377 grants totaling $12,796,007, awarded during the quarter ending September 30, 1958, for the support of basic research in the sciences, for conferences in support of science, for exchange of scientific information, and for training of science teachers. This is the first group of awards to be made during fiscal year 1959.

Grants were made to institutions and scientists in 38 states, the District of Columbia, Hawaii, and Canada. Of the 377 grants, thirty-four were made for research specifically in engineering. The research fields included are astronomy, chemistry, biology, physics, earth sciences, engineering sciences, mathematical sciences, and social sciences.

TEACHING MACHINES

DONALD J. MAYHEW AND ARLO F. JOHNSON

Department of Mechanical Engineering
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In the Mechanical Engineering Department of the University of Utah, a pilot study is being made of the use of teaching machines in engineering education. B. F. Skinner's article in *Science* of 24 October 1958 is the direct source of our interest.

The essential characteristic of the teaching machine, as the term is used here, is its ability to locate and respond to the particular instructional needs of the individual student using the device. The machine aspect of the device consists in the functions of:

1) Routing a variable sequence of instruction statements and questions to the student, and

2) Keeping accurate and conveniently tabulated records of the responses of individuals and groups.

The program which the machine handles is set up for the following sequence:

1) A graph, equation, or statement of instruction is presented to the student.

2) He is asked a question requiring interpretation of this material. (Student writes answer on paper strip integral to machine.)

3) The strip with his answer is advanced under a window to prevent alteration, and the correct answer appears at another window.

4) The student pushes either a "correct" or "incorrect" button telling the machine which branch of the program to continue on and recording the student's ability or inability. The machine "remembers" wrong answers and subsequently introduces extra instruction and questions in these areas until right answers result.

The similarity of this sequence to what goes on in a human teacher-student relationship recommends our serious consideration of its use in this age of educational ferment. Some potential advantages of its use appear to be:

1) Reduction of faculty lecture time, permitting increased faculty-student counselling time.

2) Reduced educational cost per instruction unit.

3) Freedom from present course scheduling problems.

4) Students proceed at their own pace.

5) Accurate up-to-date records of each student's comprehension are readily available.

6) Capacity for steady evolutionary improvement of the machine program by tabulating the responses of each student and thereby indicating weak places in the program.

Perhaps the machine can never have the "human quality" necessary if it were to replace the human teacher. It is too early to consider complete replacement. To those who react with aversion to the words "machine teacher," it would be better to consider the device as simply a very talented textbook. We have not attained sufficient understanding of the educational process to reject such new ideas

on theoretical grounds. We must set up controlled experiments. Such experiments assume an ability to measure the results of an educational activity. Many people question that we have any such ability. But we do give grades, and largely on the basis of impersonal test scores. It seems we have already assumed some ability to measure. The subjection of the learning process to scientific experimental techniques has long been resisted because of its complexity. Our educational crisis shows a necessity for improvement. Necessity is famous for her children.

Our preliminary study of machine teaching included spending sixty hours to develop a trial sequence of instruction, questions, and answers as a machine program to give the content of *one* of our present lecture + text assignments on column failure. It is easy to calculate the "energy barrier" to be overcome before a standard course can be converted to machine programs. The users of electronic computers have set us a very good example here. Their programs also require much time and skill to develop. They have established program libraries and organized cooperation in developing programs of interest to many users. The scope of our undertaking requires the combined efforts of many engineering educators and coordination by a national committee of the ASEE.

NUCLEAR ENGINEERING EDUCATION

Twelve engineering schools are now granting degrees in nuclear engineering according to a study made last summer by Dr. H. H. Armsby of the Department of Health, Education, and Welfare. The University of Arizona, Kansas State College, and North Carolina State College offer B.S., M.S., and Ph.D. programs. Those offering only M.S. and Ph.D. programs include Iowa State College, University of Michigan, New York University, Air Force Institute of Technology, Oklahoma State University, Pennsylvania State University, Virginia Polytechnic Institute, University of Virginia, and University of Washington. There are 149 colleges and universities known to be offering courses or conducting research, or both, in the field of nuclear physics or nuclear engineering.

AEC FILM PROGRAM

A total of 44 films, most of them in color, were prepared for the Geneva Conference on Peaceful Uses of Atomic Energy. The film program covers the production of power by nuclear means, fusion research, and the use of radioisotopes in medicine, agriculture, and industry. Prints will be available from the 12 regional film libraries of the AEC for the use of universities and other groups working in the field of atomic energy.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Bucknell University	April, 1960	H. D. Sims, Bucknell University
Illinois-Indiana	Rose Polytechnic Inst.	May, 1960	E. A. MacLean, Rose Polytechnic Inst.
Kansas-Nebraska	Univ. of Kansas	Oct. 23–24, 1959	J. S. Blackman, Univ. of Nebraska
Michigan	Univ. of Michigan	April, 1960	R. Schneidewind, Univ. of Michigan
Middle Atlantic	Pratt Institute, New York	Dec. 1959	J. I. Clower, Univ. of Delaware
Missouri-Arkansas	Univ. of Missouri	April, 1960	Jos. C. Hogan, University of Missouri
National Capital Area	Geo. Washington Univ.	Oct. 21, 1959	M. A. Mason, George Washington Univ.
New England	Univ. of Conn.	Oct. 16–17, 1959	G. A. Marston, Univ. of Mass.
North Midwest	Iowa State	Oct. 16–17, 1959	E. H. Ohlsen, Iowa State Univ.
Ohio	Fenn College Cleveland, Ohio	April, 1960	N. R. Rimboi, Fenn College
Pacific Northwest	Univ. of Idaho	May, 1960	Paul Mann, Univ. of Idaho
Pacific Southwest	Los Angeles State College	Dec. 28–29, 1959	Homer H. Grant, Univ. of Southern California
Rocky Mountain	USAF Academy	Apr. 29–30, 1960	Archie Higdon, U. S. Air Force Academy
Southeastern	Univ. of S. Car.	April, 1960	Jesse Coates, La. State
Southwest	Lamar State College, Beaumont, Tex.	Apr. 29–30, 1960	Frank Bromilow, New Mexico State Univ.
Upper N. Y.-Ontario	Rensselaer Polytechnic Institute	Oct. 23–24, 1959	W. W. Shuster, Rensselaer

Mid-Winter Meetings–1960

Cooperative Education — Jan. 15–16 — Georgia Institute of Technology
Information: J. G. Wohlford, Director of Cooperative Courses, Georgia Institute of Technology, Atlanta, Ga.

Engineering Graphics — Jan. 20–22 — Missouri School of Mines
Information: C. L. Wilson, Dean of Engineering, Missouri School of Mines, Rolla, Mo.

College-Industry Conference — Jan. 27–28 — Washington University
Information: D. A. Fisher, Dean of Engineering, Washington University, St. Louis, Mo.

EDUCATION AND RESEARCH IN INDUSTRIAL BEHAVIOR *

NORMAN N. BARISH

Dean of Engineering
College of Engineering
New York University

RAYMOND A. KATZELL

Prof., College of Engineering
New York University

Presented at a conference of the Industrial Engineering Division, at the University of California, June 18, 1958. Recommended for publication by that Division.

This paper is concerned with education and research in industrial behavior in one engineering college, that at New York University. Traditionally, the engineering profession has not been as concerned with the behavior patterns of human beings as they have been with the behavior patterns of materials and machines. In more recent years, however, the scope of engineering activities has broadened to include systems with human components, and many of the nonphysical sciences have been maturing and developing. Engineering has thus been turning to many of the nonphysical sciences to provide assistance in the solution of engineering problems and applications.

Thus we find that in such fields as sanitary engineering, engineering of the work place and equipment, and safety engineering, the biological and medical sciences have been contributing to the development of better engineering practice.

In the field of industrial and management engineering, the behavioral sciences have similarly become more important in providing answers to industrial problems. The definition of industrial engineering as accepted by the American Institute of Industrial Engineers takes particular cognizance of the social sciences as providing specialized knowledge for practice in this field.

In the Industrial and Management Engineering Department at New York University, we have been concerned about the application of behavioral sciences to engineering problems. This concern has expressed itself in the composition of our undergraduate curriculum and courses of study, in changes in emphasis in our graduate program leading to the masters and doctors degrees, and in our research program.

Undergraduate Program in Industrial Engineering

Industrial engineering involves design, evaluation, testing, improvement, and installation of systems in which the human as well as the machine components are significant factors affecting the effectiveness of system performance. Some rigorous training in behavioral sciences is included in our undergraduate industrial engineering curriculum to give our students skill in utilizing psychological methods and principles related to the work of the

industrial engineer; to develop an understanding of how human and social phenomena are susceptible to scientific investigation and prediction; and to familiarize our students with some principles of human behavior, with a view towards a better understanding of themselves and other people.

With these purposes in mind, undergraduate students in industrial engineering generally take 12 semester hours in psychology. These hours are distributed as follows:

1. A three semester-hour course in General Psychology, involving two lecture hours and one recitation demonstration hour for one term. This course covers an introduction to psychological science, with emphasis on scientific methodology and the study of behavior. Special attention is paid to basic psychological processes (sensation, conditioning, perception, and motivation) and complex psychological processes (learning, frustration and conflict, language, and problem solving).

2. A full-year six semester-hour sequence entitled Psychology in Industry, having two lecture hours and three laboratory hours per week for two semesters. This course covers principles and methods of psychology as related to human behavior in industry. Topics covered include measurement of employee qualifications and performance, training and development, conditions for effective work, man-machine systems, motivation and morale, leadership, labor and management relations, and consumer preferences and reactions. This course covers many of the topics that would normally be covered in various advanced psychology courses, but selected for relevance to and put in the context of industrial applications. The laboratory is designed to bolster a realization that principles of human behavior can better be generated from scientific research than on the basis of personal hunch and folklore.

3. A three semester-hour course in one of the following areas of special interest to the student: the Psychology of Personality; Principles of Educational Psychology; Attitudes and Public Opinion; or Physiological Psychology.

In addition to these courses our undergraduate students take applied personnel management courses in labor and personnel management and human relations.

Graduate Instructional Program

Our course offerings in behavioral science on the graduate level have been developed with two functions in mind: for those students interested in the more traditional industrial engineering areas such as production, methods, quality control, etc., we want to provide a basic background in behavioral science which is not usually acquired in the normal undergraduate program; for those graduate students interested in a minor in industrial psychology, we want to provide basic training which will enable them to continue studies in this area in the graduate psychology department of the University.

We have therefore instituted two graduate courses which attempt to provide in one year's time approximately the same fundamental grasp of behavioral science which is provided to our undergraduates in the two-year program previously described. The two courses described below include both recitation-lecture and laboratory work.

The first course, entitled Individual Behavior in Industry, covers essentially the psychology of the individual at work: what motivates him, how he learns and thinks, how his personality develops and functions, how his sen-

sory and reactive capacities are related to equipment operation, and so on.

The second course, entitled Group Behavior in Industry, covers the social psychology and sociology of work: how man's attitudes and motivations are related to other people, the nature of morale and of leadership, the analysis of business organization as a social system, and so on.

For the student in the second category mentioned previously who desires to take further work in the industrial psychology area, these two courses provide the background which will enable him to take further work in the graduate psychology department, with courses in such subjects as Industrial Psychology, Personnel Psychology, Social Psychology, Experimental Psychology, Psychological Measurement, and Physiological Psychology.

In addition to these courses in psychological science, our industrial engineering graduate program includes courses in Job Evaluation and Wage Incentives, Personnel Management, Labor Relations, and Human Engineering.

The question should be considered at this point as to just what are the educational objectives which underlie the graduate offerings just described. For students in the first category, whose professional interests lie primarily within the more traditional boundaries of industrial engineering, the objective is relatively modest: it is to furnish such students with a somewhat better appreciation of and sensitivity to the human factors which enter into the systems and procedures with which they will be working professionally; the aim is to equip these students with attitudes, knowledge, and skills relating to humans at work that will enable them better to plan, design, and execute their engineering responsibilities. For example, we wish such graduates to be skillful not only in designing the technological features of methods improvement, but to know how to take into account the possible reactions of workers and supervisors to a given technological system.

For students in the second category, who undertake a considerable amount of advanced work in behavioral science, along with training in industrial engineering, the educational objectives are more complicated. First, it should be noted that this type of program emphasis is likely to take place at the doctoral rather than the master's level. Students electing such a program will ordinarily aim toward a career of research and professional service in fields where human factors account for a major proportion of the variance in the effectiveness of the systems under consideration.

We can identify roughly four subdivisions in which the graduates of such a program would be especially fitted to make a contribution:

1. Design of equipment and conditions of work in the light of capacities and characteristics of the operators, that is, the field that has come to be known as human engineering or biomechanics.

2. Design of complex systems, typically involving a number of human operators performing various tasks with different types of equipment; this comprehends what is usually termed "systems research."

3. Design of managerial methods and procedures whose effectiveness is heavily dependent on motivations, attitudes, and other characteristics of the humans who work with and under these procedures; under this heading comes a variety of related activities, including job design, and organization planning.

4. Original research in one or more of the above fields, for students whose backgrounds and inclinations lie in theoretical and experimental direc-

tions; in effect, this is the area coming to be known as "management science."

Research Centers

Another aspect of our program for training students in behavioral science is our research work. Research is important, of course, for its own sake as a legitimate contribution that a university makes to modern society. However, it also ties into the training program in several ways: by making available a larger number of staff members who represent a wider spectrum of competence, by providing research experience for those graduate students who receive research appointments or who do their theses on the research projects under way, and by adding to the equipment and facilities available for both instruction and student research.

At New York University, we have two centers of research related to the topic under discussion. One of these is a human engineering research center, which has been functioning for some 15 years in the Research Division of our College of Engineering. For the past several years, this program has been under the direction of Mr. Renato Contini; it currently has a staff of over 20 researchers, including psychologists and biologists as well as engineers. Over the years, a number of graduate students in the Department of Industrial and Management Engineering have held appointments in this research enterprise. The research work done in this program has covered a variety of topics that fall both in the biomechanics and systems research categories. A rather unique set of investigations over the years has been concerned with the design of prosthetic devices.

The second of these research centers has just been established, and its work is still in the planning stage. While we therefore cannot describe specific achievements, we would like to indicate the type of research program which is projected and which we hope will get under way during the coming year. If you will recall the four sub-fields that were described above as foci for the industrial engineer with heavy training in the behavioral as well as physical sciences, you will recognize that the first two of them are covered by the aforementioned human engineering research program, namely, biomechanics and systems research. The new research center is aimed primarily at the latter two sub-fields mentioned. These are the sub-field of managerial practices and methods and the sub-field of management science, especially where problems in these sub-fields are saturated with psychological and social considerations. In view of the nature of these topics, we believe that it is particularly significant that this Center, which has been named the Research Center for Industrial Behavior, is jointly sponsored by the University's Department of Industrial and Management Engineering and its Department of Psychology.

The kind of research planned for this Center stems from our belief that behavioral science, as applied in industry and government, has heretofore remained largely independent of the mainstream of basic research, and that the consequences of this separation are unfortunate for both the basic and applied branches of the field. On the one hand, applications to industry lag when they fail to capitalize on fundamental advances in basic knowledge about behavior. Conversely, the total field suffers from the lack of opportunity to profit from verification or refutation of theoretical developments in the real life setting found in industry. Furthermore, the applied scientist's efforts to cope with practical problems may suggest hypotheses that had hitherto escaped the attention of the basic scientist.

Bridging this gap is not simply a matter of the wholesale industrial adaptation of the results of basic research on the basis of judgment. Once a principle has been identified through basic research, the nature and extent of its applicability in industry remain to be established. This intermediate stage requires what has been termed, in the physical sciences, "applied research." Applied research is the scientific investigation of a fact or principle, as regards its applicability to a given need or objective. As this audience well knows, until this step is taken, the findings of basic research may remain theoretical curiosities; unless it is taken, attempts to apply such findings may be totally misguided.

The Research Center for Industrial Behavior plans, then, to make this sparsely cultivated field a major area for its activities: investigations designed to extend systematically the results of basic research and theorizing in behavioral science to the understanding of human behavior and performance in industrial settings.

In carrying out this program, it is planned that hypotheses for investigation will be developed through: (1) systematic and continuing review of basic research in psychological science, with a view toward identifying those subjects and methods which appear to have particular relevance to industrial behavior; (2) systematic and continuing review of industrial issues in which human factors are basic; and (3) the deliberate effort to envision applications of basic psychological science to the human issues in industrial management.

Step 3 will typically find expression in terms of the applied research process previously mentioned, for the applications will characteristically take the form of hypotheses concerning what *may* be true of the behavior of people under given industrial conditions. Research will then be needed to ascertain the conditions, if any, under which a basic psychological principle or theory may be applied.

The specific form of this applied research is likely to vary from topic to topic. Some of it may take the form of survey research, intended to divulge the effects of various practices currently encountered in industry. Sometimes it may take the form of simulation research, where some of the relevant variables are reconstructed under laboratory conditions. The field experiment will always get into the picture sooner or later, too, where the experimental conditions or changes are deliberately introduced in real-life situations.

We have several topical areas in which research of this type is planned. To give a concrete example, let us consider one of them: the area of problem-solving and decision-making by managerial teams. The effectiveness of this process, we all recognize, is vital to the success of any enterprise. The question arises as to what practices and variables affect the adequacy of such decisions. Some of the parameters of this problem are, of course, not primarily psychological, for example, the question of the kind and accuracy of information available and the correctness of the prediction model that may be developed.

However, there *are* many relevant factors which are psychological in nature. Basic psychological research on the problem-solving behavior of groups has already revealed the impact of such variables as: the status relationships among the members of the team; the distribution of effort on getting and providing information, on evaluation of alternatives, and so forth; the heterogeneity of opinions and outlooks among those involved in reaching the decision; and many other such variables. While these basic research findings are highly suggestive of implications for improving managerial

decisions, we really don't know whether they obtain or, if so, just how to apply them successfully. It is to the latter kinds of problems that the efforts of the Research Center for Industrial Behavior will be directed. The connection is apparent between findings from such research, and the industrial engineer's concern with organization, with information processing, and with decision-making. Other projected research areas would similarly relate to the concerns of the industrial engineer.

Summary

We have attempted here to summarize the instructional and research programs in behavioral science as they relate directly to the objectives and activities of Industrial and Management Engineering at New York University. We hope that these programs will assist the development of graduates of our institution who will be more effective contributors to their profession through a greater understanding of and skill in dealing with the human aspects of the systems and methods with which they work. We hope, too, that our efforts will contribute to the development of new knowledge in those aspects of behavioral science that are germane to the expanding concerns of tomorrow's industrial and management engineers.

ENGINEERING ON TV

"Engineering at Work '59," a series of six television programs dealing with basic concepts of science and engineering, has been made available to a nationwide audience through the facilities of the National Educational Television Network and local scientific societies.

Prepared as a joint venture by Carnegie Institute of Technology and Westinghouse Broadcasting Company, "Engineering at Work '59" was shown first in Pittsburgh on KDKA–TV during February and March of this year. Kinescope recordings of the series are available to interested groups.

RESEARCH REACTOR AT M.I.T.

The Massachusetts Institute of Technology put the first atomic reactor in New England into operation last August as a facility for research and for training nuclear engineers.

The Reactor was designed at M.I.T. under the direction of Dr. T. J. Thompson, who has had extensive experience in the field of atomic energy. Since 1942, when the first sustained chain reaction was achieved at the University of Chicago, dozens of reactors have been built in various parts of the world. The M.I.T. Reactor is similar to one at Argonne National Laboratory near Chicago, known as the CP-5. The University of Michigan, North Carolina State University, Pennsylvania State University and The Armour Institute also have non-Government research reactors.

NSF Fellowships for Graduate Teaching Assistants For Summer 1960

The National Science Foundation has announced that approximately 550 Summer Fellowships for Graduate Teaching Assistants will be offered for the summer of 1960. Designed to enable graduate teaching assistants to devote their full summer to study and research, the fellowships will be offered in the sciences, mathematics and engineering.

In this, the second year of operation of the program, teaching assistants at 150 institutions (see following list) which are authorized to confer the doctoral degree in at least one of the sciences will be eligible to apply for summer fellowships. First-year participation in the program had been limited to 115 institutions which had awarded a specified minimum number of science doctorates.

Teaching assistants at the participating institutions will apply through their own institutions and will be screened and evaluated initially by their faculties. They will be judged solely on the basis of ability, as indicated by academic records, reference reports and other evidences of attainment. The applications will be forwarded—together with the institution's recommendations—to the National Science Foundation. Applicants will then be evaluated for the Foundation by panels of scientists especially chosen for this task by the National Academy of Sciences-National Research Council. At both levels of review and evaluation, as well as in the final selection of Fellows by the National Science Foundation, ability will constitute the sole basis for judgment.

Summer tenures from eight to twelve weeks may be selected by the Fellow. The weekly stipend will range from a minimum $50 up to a maximum of $75 per week, the exact amount to be determined by the Fellow's institution according to local conditions. Payment of stipends will be made by the participating institutions from funds provided them for that purpose by the Foundation. In addition, the Foundation will pay to each institution the tuition and fees of its Fellows.

Summer Fellowships for Graduate Teaching Assistants will be offered for study in the mathematical, physical, medical, biological, and engineering sciences, as well as in anthropology, psychology (excluding clinical areas), and certain selected social sciences. The social sciences included are geography, mathmatical economics, econometrics, demography, information and communication theory, experimental and quantitative sociology, and the history and philosophy of science, where they conform to accepted standards of scientific inquiry by fulfilling the requirements of the basic scientific method as to objectivity, verifiability, and generality.

Application materials may be obtained from the Graduate Dean of a participating institution, or from the Fellowships Section, Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C. Teaching assistants in participating institutions must submit their applications to their Graduate Deans by December 11, 1959. Shortly after March 15, 1960, all applicants will be notified, by the schools through which they applied, of the disposition of their applications.

INSTITUTIONS PARTICIPATING IN COOPERATIVE GRADUATE FELLOWSHIPS PROGRAM FOR 1960–1961

Alabama
- Alabama Polytechnic Institute
- University of Alabama

Alaska
- University of Alaska

Arizona
- University of Arizona

Arkansas
- University of Arkansas

California
- California Institute of Technology
- Claremont Graduate School
- College of the Pacific
- Stanford University
- University of California (Northern Division)
- University of California (Southern Division)
- University of Southern California

Colorado
- Colorado State University
- Colorado School of Mines
- University of Colorado
- University of Denver

Connecticut
- University of Connecticut
- Yale University

Delaware
- University of Delaware

District of Columbia
- American University
- Catholic University of America
- Georgetown University
- George Washington University
- Howard University

Florida
- Florida State University
- University of Florida

Georgia
- Emory University
- Georgia Institute of Technology
- University of Georgia

Hawaii
- University of Hawaii

Illinois
- Illinois Institute of Technology
- Loyola University (Chicago)
- Northwestern University
- Southern Illinois University
- University of Chicago
- University of Illinois

Indiana
- Indiana University
- Purdue University
- University of Notre Dame

Iowa
- Iowa State College of Agriculture and Mechanic Arts
- State University of Iowa

Kansas
- Kansas State University
- University of Kansas

Kentucky
- University of Kentucky
- University of Louisville

Louisiana
- Louisiana State University and Agricultural and Mechanical College
- Tulane University

Maine
- University of Maine

Maryland
- Johns Hopkins University
- University of Maryland

Massachusetts
- Boston College
- Boston University
- Brandeis University
- Clark University
- Harvard University
- Lowell Technological Institute
- Massachusetts Institute of Technology
- Radcliffe College
- Smith College
- Tufts University
- University of Massachusetts
- Worcester Polytechnic Institute

Michigan
- Michigan State University of Agriculture and Applied Science
- University of Michigan
- Wayne State University

Minnesota
- University of Minnesota

Mississippi
- Mississippi State University
- University of Mississippi

Missouri
- St. Louis University
- University of Missouri
- Washington University

Montana
- Montana State College
- Montana State University

Nebraska
- University of Nebraska

New Hampshire
- University of New Hampshire

New Jersey
- Princeton University
- Rutgers, The State University
- Stevens Institute of Technology

New Mexico
- New Mexico Institute of Mining and Technology
- New Mexico State University of Agriculture, Engineering and Science
- University of New Mexico

New York
- Adelphi College
- Alfred University
- Columbia University
- Cornell University
- Fordham University
- New School for Social Research
- New York University
- Polytechnic Institute of Brooklyn
- Rensselaer Polytechnic Institute
- St. Bonaventure University
- St. John's University
- State University College of Forestry at Syracuse University
- Syracuse University

Union College and University
University of Buffalo
University of Rochester
Yeshiva University

North Carolina
Duke University
North Carolina State College of Agriculture and Engineering
University of North Carolina in Chapel Hill

North Dakota
North Dakota Agricultural College
University of North Dakota

Ohio
Case Institute of Technology
Ohio State University
Ohio University
University of Akron
University of Cincinnati
Western Reserve University

Oklahoma
Oklahoma State University
University of Oklahoma

Oregon
Oregon State College
University of Oregon
University of Portland

Pennsylvania
Bryn Mawr College
Carnegie Institute of Technology
Duquesne University
Hahnemann Medical College
Jefferson Medical College of Philadelphia
Lehigh University
Pennsylvania State University
Philadelphia College of Pharmacy and Science
Temple University
University of Pennsylvania
University of Pittsburgh

Rhode Island
Brown University
University of Rhode Island

South Carolina
Clemson College
Medical College of South Carolina
University of South Carolina

South Dakota
South Dakota State College of Agriculture and Mechanic Arts

Tennessee
George Peabody College for Teachers
University of Tennessee
Vanderbilt University

Texas
Agricultural and Mechanical College of Texas
Baylor University
Rice Institute
Texas Technological College
University of Houston
University of Texas

Utah
University of Utah
Utah State University of Agriculture and Applied Science

Virginia
Medical College of Virginia
University of Virginia
Virginia Polytechnic Institute

Washington
State College of Washington
University of Washington

West Virginia
West Virginia University

Wisconsin
Institute of Paper Chemistry (affiliated with Lawrence College)
University of Wisconsin

Wyoming
University of Wyoming

FOUNDATION ANNOUNCES SCIENCE FACULTY AND SENIOR POSTDOCTORAL FELLOWSHIP AWARDS

The National Science Foundation has announced award of 302 Science Faculty Fellowships in the sciences for the fiscal year 1959. These fellowships are offered as a means of improving the teaching of science, mathematics and engineering in American colleges and universities. The primary purpose of the awards is to provide an opportunity for college and university science teachers to enhance their effectiveness as teachers.

The Foundation also announced award of 82 Senior Postdoctoral Fellowships in the sciences for the fiscal year 1959, selected from 242 applicants. Of the 544 total, 88 were in engineering.

A NOTE ON DIMENSIONAL ANALYSIS

R. V. SMITH

Associate Professor of Mechanical Engineering
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Sometimes one is confronted with a choice of two rather undesirable alternatives in using experimental data to establish a desired relationship between variables. The choice is to express the relationship based on a proposed mechanism (heavily laden with assumptions) which explains the data at hand or to establish dimensionless groups and determine the relationship between the groups using the experimental data. This note is to present the case for the mechanistic approach.

The difficulty in establishing relationships between dimensionless groups is that so many forms of the function are possible that even with large quantities of experimental data it is difficult, if not impossible, to finally establish the true form of the function. Perhaps a case history will substantiate the point.

In forced convection, heat transfer studies of cylindrical bodies in air flow normal to their axis, one may express a conventional set of dimensionless groups in this form:

$$N_{Nu} = C(N_{Re})^m(N_{Pr})^n$$

and simplified for air:

$$N_{Nu} = C'(N_{Re})^m.$$

In a widely accepted work, Hilpert (1) presents a curve showing the relationship and, in curve fitting, shows the constant, C', to vary from 0.891 to 0.0239 and the exponent, m, to assume values from 0.330 to 0.805. Subsequent investigators have found it desirable to rearrange and omit some of the terms, to add other quantities such as a temperature correction, specific heat and a second constant to improve the "curve fitting" quality of the equation.

A solution of the differential equations for the heat transfer through the laminar boundary layer near the stagnation point indicates the exponent for the Reynolds No. to be ½. This value was used in a more recent correlation by Hegge Zijnen (2) who found in fitting the work of Hilpert and many others a combined empirical and theoretical approach was most useful producing the expression

$$N_{Nu} = 0.35 + 0.5(N_{Re})^{0.5} + 0.001(N_{Re})$$

which is quite different from Hilpert's expressions, from expressions of those who followed Hilpert and, perhaps, from investigators who will follow Hegge Zijnen.

Surely, a glance at the historical development of the expressions reveals that, despite the large amount of good work which has been reported, the "true" form of the function is extremely difficult to establish from experimental data. When possible, even a crude mechanistic approach should, in the longer view, produce more useful relationships and, certainly, a clearer understanding of the process.

In two excellent texts on dimensional analysis by Bridgman (3) and Duncan (4) both authors warn against overzealous use of dimensional concepts. Perhaps the statement with which Duncan prefaces his text best states the usefulness and limitations of the dimensional approach. "This

is the first book in which dimensional analysis is discussed in its proper context, namely, the theory of physical similarity."

Bibliography

1. R. Hilpert, *Forsh Gebiete Ingenieunw* **4**, 215 (1933).
2. B. G. van der Hegge Zijnen, *Applied Sci. Res.* Sec. A, **6**, 129 (1956).
3. P. W. Bridgman, *Dimensional Analysis*, Yale University Press, New Haven, 1951.
4. W. J. Duncan, *Physical Similarity and Dimensional Analysis*, Edward Arnold and Co., London, 1953.

Teaching Positions Available

ADDITIONS TO ELECTRICAL ENgineering faculty desired by engineering school of midwestern university at all professorial ranks. To conduct research and teach both undergraduate and graduate classes. Research interests of considerable importance. Send resume of education and experience to 50-1, JOURNAL OF ENGINEERING EDUCATION, University of Illinois, Urbana, Illinois.

What *is* the Current B.Ch.E. Curriculum?

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Summary

The following things have been accomplished:

1. It has been determined what the average American B.Ch.E. curriculum consists of, both qualitatively and quantitatively.

2. The hard core of this curriculum has also been defined and determined.

3. A detailed procedure has been established for analyzing and comparing chemical engineering curricula of the past, present and future.

4. It has been discovered what material is removed from the bachelor's curriculum when the cultural content is increased to the extent currently recommended by the Committee on Evaluation of Engineering Education of the ASEE.

5. It has been determined where and to what extent the current curriculum is weak with respect to the above-mentioned committee's recommendations.

Introduction

"The curriculum" is often a factor of importance in discussions of engineering education and accreditation. The thought came to mind that it would be advantageous to know what it was when discussing it, a radical but refreshing departure from normal practice. To this end, the bulletins of eighty-seven United States colleges and universities were examined for this survey. So far as known, they represented the complete roster of institutions accredited in chemical engineering at the time.

It was felt that a knowledge of what the average accredited American B.Ch.E. curriculum of 1956–57 contained would be valuable in several respects. It would permit comparison with past and future curricula, thus acting as an aid in evaluating changes and trends. It would also afford a ready means for comparing any particular curriculum with the current "norm."

A Statistical Analysis of Accredited B.Ch.E. Curricula of 1956–57.
Paper presented at The American Institute of Chemical Engineers, Golden Jubilee Symposium on Chemical Engineering Education, Philadelphia, Pa., June, 1958.

Procedure

In compiling the statistical results presented below, the curricula of six institutions of the 87 were omitted for one reason or another; e.g., the bulletins presented the curriculum in a manner that precluded analysis in terms of credits and student effort per course or subject; or they exceeded in content the upper limit for an alleged four-year bachelor's curriculum. This latter point is amplified below.

The contents of all the curricula were reduced, as nearly as could be determined, to a common unit—what may be called an ECPD semester credit. One such credit presumably represents three actual hours of the student's time per week throughout a conventional fifteen-week semester with examinations. It includes all time spent on the course, whether in recitation, lecture, laboratory or outside preparation. It thus represents a total of approximately 50 hours of the student's time.

On this basis, the average American B.Ch.E. curriculum of 1956–57 contains 147 credits (Table 1, Item 6). How-

ever, this gross number of credits should be corrected to allow for certain variables of practice if valid evaluations or comparisons of curricula are to be made. For example, many institutions currently give credit toward the bachelor's degree for courses in basic mathematics that other institutions regard as normal high school training and hence part of the normal entrance requirement (specifically, such items as algebra and trigonometry). Some institutions allow credit toward the degree for military studies or physical education, others do not. Sectarian colleges usually allow credit for religious training courses, which nonsectarian curricula do not even contain. Therefore, from the gross number of credits there was deducted the sum of credits for courses in physical, military and religious training, introductory and review mathematics (mathematics preceding analytical geometry) and certain unusual credit allowances such as those granted for attendance at assemblies. The remainder is reported as the net number of credits (Item 7, Table 1). The average number of net credits for an accredited curriculum is 137 (136.9). It is felt that this net credit figure is for many purposes more meaningful than the gross credit figure.

It was soon discovered that one alleged four-year curriculum contained 160 net ECPD credits while one so-called five-year curriculum contained 146 net ECPD credits. In this study the former figure was arbitrarily adopted as the absolute maximum for a "four-year" curriculum. This represents a rather formidable eight semesters of 20 net credits each, or eight 19-credit semesters with one 8-credit summer session. With this upper limit arbitrarily established, the accredited "four-year" chemical engineering curricula included in this survey ran a gamut of 118 to 160 net credits, a rather substantial variation in substance, at least on paper. Curricula containing in excess of 160 net ECPD credits (there are three such) were not included in calculating the "average American accredited B.Ch.E. curriculum of 1956–57."

One hundred and eighteen and 160 are extreme values. For 72% of the curricula, the net credit content lies between 131 and 141. The median value is 137.

With regard to the practice of maintaining a common curriculum for the four major branches of engineering (chemical, civil, electrical and mechanical), the breakdown is as follows. Of the institutions surveyed those having

2 years of "common curriculum" = 8%
1½ years of "common curriculum" = 1%
1 year of "common curriculum" = 59%
⅔ year of "common curriculum" = 1%
0 years of "common curriculum" = 31%

Definitions and Explanations Regarding Table 1

Each item appearing in Table 1 has been numbered for ready reference. Wherever deemed necessary, the item is defined or discussed below in order to show how it was arrived at and to minimize problems in semantics, present or future. The curriculum content has been subdivided under ten main headings. These were chosen for one or both of two reasons: (a) they seemed logical and fruitful to the author or (b) they afforded convenience in comparing a given curriculum with current recommendations of the Committee on Evaluation of Engineering Education of the ASEE.[1] This body will hereinafter be referred to simply as the ASEE Committee. Also, the publication cited below will be referred to as the Report.

Item 1. *Subject.* No comment or explanation deemed necessary.

Item 2. *Range of ECPD Credits.* This is the extreme range, from the lowest number of ECPD credits allotted to a subject by one institution to the highest number allotted by another. The ECPD credit has been defined under "Proceedure."

Item 3. *Average Number of ECPD Credits.* Each value in this column represents the total number of credits assigned to the item by all the institutions surveyed divided by the number of institutions surveyed. This column therefore represents the average American accredited four-year B.Ch.E. curriculum of 1956–57.

[1] "Report on Evaluation of Engineering Education, 1952–55." Am. Soc. Eng'g Educ., June 15, 1955.

TABLE 1

THE AVERAGE AMERICAN B.CH.E. CURRICULUM OF 1956–57

Item	Subject	Range of ECPD Credits	Average Number of ECPD Credits: Accredited Curricula of 1956–57		Percentage of Accredited Institutions Offering	Average No. of ECPD Credits When Offered
	Item 1	Item 2	Item 3		Item 4	Item 5
6.	Gross Credits	130–160	147.0		—	—
7.	Net Credits	118–160	136.9		—	—
8.	Non-technical Subjects					
9.	Written Communication Skills	0– 16	6.5		98.8	6.6
10.	Oral Communication Skills	0– 4	1.1		43.2	2.4
11.	Subtotal, Communication Skills	0– 16	7.6		98.8	7.7
12.	Humanities, Required Courses	0– 24	4.0		63.0	6.3
13.	Social Studies, Required Courses	0– 14	3.1		51.9	5.9
14.	Other Required Cultural Courses	0– 18	1.3		22.2	5.7
15.	Non-technical Electives	0– 24	6.4		76.5	8.3
16.	Subtotal, Cultural Courses	3– 30	14.7			
17.	Physical Education, etc.	0– 8	1.8		50.6	3.5
18.	Military Studies	0– 12	3.1		48.1	6.5
19.	Other Non-technical	0– 4	0.3		23.5	1.3
20.	Subtotal, Physical, Military, etc.	0– 16	5.2		84.0	6.2
21.	ALL NON-TECHNICAL SUBJECTS, TOTAL	16– 43		27.5	—	—
22.	Mathematics, Chemistry and Physics					
23.	Introductory & Review Mathematics	0– 10	4.4		79.0	5.6
24.	Analytical Geometry & Calculus	8– 16	11.6		100.0	11.6
25.	Differential Equations & Other	0– 6	1.3		44.4	2.8
26.	Subtotal, Mathematics	12– 22	17.3			
27.	General Chemistry	4– 10	8.0		100.0	8.0
28.	Physical Chemistry	6– 13	8.5		100.0	8.5
29.	Organic Chemistry	5– 11	8.5		100.0	8.5
30.	Quantitative Analysis	0– 8	4.2		98.8	4.2
31.	Qualitative Analysis	0– 4	1.3		44.4	3.0
32.	Other Chemistry	0– 5	0.3		9.9	3.3
33.	Subtotal, Chemistry	24– 37	30.8			
34.	General Physics	8– 18	10.8		100.0	10.8
35.	Modern Physics	0– 3	0.2		8.6	2.6
36.	Subtotal, Physics	8– 20	11.1			
37.	MATH., CHEMISTRY & PHYSICS, TOTAL	49– 68		59.2		
38.	Engineering Graphics					
39.	GRAPHICS, TOTAL	0– 9	4.7	4.7	97.5	4.8
40.	Economics, Business Law, Business Administration and Allied					
41.	Economics, Principles of	0– 6	2.2		55.6	3.9
42.	Economics, Engineering	0– 6	0.7		23.5	2.8
43.	Bus. Law, Bus. Admin., etc.	0– 6	0.5		18.5	2.9
44.	ECO., BUS. LAW, BUS. ADMIN., TOTAL	0– 11		3.4	70.4	4.8

TABLE 1—(*Continued*)

Item	Subject	Range of ECPD Credits	Average Number of ECPD Credits: Accredited Curricula of 1956–57		Percentage of Accredited Institutions Offering	Average No. of ECPD Credits When Offered
	Item 1	Item 2	Item 3		Item 4	Item 5
45.	Mechanics of Solids					
46.	Mechanics	0– 7	3.7		97.5	3.8
47.	Mechanics of Materials	0– 5	3.1		97.5	3.2
48.	MECHANICS OF SOLIDS, TOTAL	2– 10		6.8	100.0	6.8
49.	Elementary Electrical Engineering					
50.	Elementary Electrical Engineering	0– 8	4.7		98.8	4.8
51.	Elementary Electronics	0– 3	0.3		9.9	2.6
52.	ELECTRICAL ENGINEERING, TOTAL	0– 9		5.0	100.0	5.0
53.	Nature and Properties of Materials A and B					
54.	Physical Metallurgy	0– 4	1.2		40.7	2.9
55.	Other Category A Courses	0– 3	0.1		5.0	2.0
56.	Metallurgy	0– 5	0.4		12.3	2.9
57.	Other Category B Courses	0– 5	0.6		28.4	2.1
58.	MATERIALS, TOTAL	0– 8		2.3	67.9	3.4
59.	Supplementary Sciences and Practices					
60.	Biology and Geology	0– 8	0.2		4.9	3.8
61.	Heat Power	0– 6	0.8		23.5	3.4
62.	Shop Practice	0– 3	0.4		23.5	1.7
63.	Other	0– 4	0.4		13.6	2.8
64.	SUPPLEMENTARIES, TOTAL	0– 8		1.8	45.7	3.9
65.	Chemical Engineering					
66.	Material and Energy Balances	0– 8	3.8		98.8	3.9
67.	Thermodynamics	2– 10	4.8		100.0	4.8
68.	Chemical Kinetics	0– 5	0.5		18.5	2.5
69.	Subtotal, Chem. Process Principles	5– 17	9.1			
70.	Unit Operations Theory	4– 13	7.6		100.0	7.6
71.	Unit Operations Laboratory	2– 7	4.1		100.0	4.1
72.	Subtotal, Unit Operations	8– 16	11.7		100.0	11.7
73.	Chemical Engineering Design	0– 12	3.7		90.1	4.1
74.	Chemical Technology	0– 7	2.7		75.3	3.6
75.	Investigational Skills	0– 12	2.5		70.4	3.5
76.	Introduction to Chemical Engineering	0– 4	0.8		38.3	2.0
77.	Instrumentation	0– 5	0.7		32.1	2.3
78.	Unit Processes	0– 3	0.6		27.2	2.2
79.	Trips	0– 3	0.3		21.0	1.5
80.	Fuels and Lubricants	0– 4	0.3		13.6	1.9
81.	Other	0– 8	0.6		19.8	2.9
82.	Subtotal	5– 23	12.1			
83.	CHEMICAL ENGINEERING, TOTAL	23– 45		32.9		
84.	Technical Electives					
85.	TECHNICAL ELECTIVES, TOTAL	0– 12	3.6	3.6	65.4	5.5

Items 4 and 5. If all the institutions included in this survey offer the material in question, Item 4 is 100% and Items 3 and 5 are identical. If only half offer the material, Item 5 is double Item 3.

Item 6. *Gross Credits.* An effort was made to reduce all curricula to the common unit of ECPD credits by information gathered from the individual bulletins.

Item 7. *Net Credits.* As explained earlier, the net credit figure removes certain variables of procedure. It is the gross credits minus Items 20, 23, and that part of Item 14 that consists of credits allowed for religious training courses (see Item 14 below).

Item 8. *Non-technical Subjects.* In establishing a definition of "non-technical subjects," the most difficult and controversial points that arise are whether or not to regard various economics courses as cultural and, more broadly, whether Economics, Business Administration and Allied Subjects are to be classified as technical or non-technical. (On this Economics question, the ASEE Committee is vague and indecisive, probably purposely so.)

Proceeding from the fact that economic factors enter into many engineering calculations and decisions, in this survey courses in Economics, Business Administration and allied subjects are regarded as technical and professional rather than non-technical and cultural. Accordingly, they are arbitrarily classified with the technical subjects and appear under Items 41, 42 and 43.

Item 9. *Written Communication Skills.* This item covers courses commonly called English Composition, Composition and Rhetoric, English I and II, etc. Included here are courses devoted to writing skills alone, and also those devoted to the simultaneous development of both written and oral techniques of communication. In some cases, courses presented under a title such as English Composition or English II are devoted partly to the development of communication skills and partly to belles lettres. Whenever the bulletin description permitted, a guestimate was made of the percentage of cultural material. This part was then shifted to Humanities (Item 12).

Item 10. *Oral Communication Skills.* Listed here are courses variously described as Speech, Public Speaking or Oral Communication, and devoted solely to speaking skills.

Item 11. *Subtotal, Communication Skills.* Subtotals are listed to the left, totals to the right of the credit column all through Tables 1 and 3.

Item 12. *Humanities, Required Courses. Required* courses in the humanities are here included. It is, of course, obvious that this item does not necessarily represent the total humanities content of the curriculum. A substantial fraction may be in non-technical electives (Item 15).

Item 13. *Social Studies, Required Courses.* The same remarks apply to this item as apply to Item 12. Also, in this study, the usual elementary courses in Economics have not been included amongst cultural material. They appear as technical material in Item 41, Principles of Economics.

Item 14. *Other Required Cultural Courses.* Included here are such subjects as Philosophy, Foreign Languages, Logic, Psychology and Ethics. Also included in this item are courses in religious training.

Item 15. *Non-technical Electives.* All non-technical electives are included under this item. There is some unavoidable confusion in that the non-technical *electives* lists included in many engineering curricula embrace not only courses defined in this report as cultural but also courses classified herein under Economics, etc. (Item 40) and Communication Skills (Items 9 and 10). Item 15, therefore, consists largely but not solely of "cultural" material. In a few college bulletins, credits are assigned merely to "electives" with no indication as to whether the elective material is technical or non-technical. (This practice should not be encouraged.) In these cases, half the credit was arbitrarily included here and half under Technical Electives (Item 85).

Item 16. *Subtotal, Cultural Courses.* See Item 15.

Item 17. *Physical Education, etc.* This covers courses in Physical Training, Physical Education, Health Education, etc. They are included in this survey only when the courses are required and carry credits toward the degree.

Item 18. *Military Studies.* These courses in Military Science, Air Science, etc., like those of Item 17, are included in this survey only when the courses are required and carry credit toward the degree. Hence the percentage of accredited institutions at which military studies *may* be pursued is greater than the 48.1 per cent listed in Table 1.

Item 19. *Other Non-technical.* This item embraces credit for material presented under such varied titles as Orientation, Introduction to Engineering, Professional Development, Guidance, Seminar and Coordination. The courses have in common the fact that

they are essentially informal. They educate the student in various phases of university or professional life without requiring much, if any, preparation or formal, organized intellectual attack. (See discussion of Item 76 below.)

Item 20. *Subtotal, Physical, Military, etc.* This subtotal is one of the items subtracted from the gross credits to obtain the herein defined net credit content of a curriculum.

Item 22. *Mathematics, Chemistry and Physics.* This subdivision is presumed to coincide roughly with what is defined by the ASEE Committee on Evaluation of Engineering Education as Basic Science.

Item 23. *Introductory and Review Mathematics.* This item consists of algebra, trigonomtery and, in general, any mathematics ordinarily preceding analytical geometry. It is another of the items subtracted from gross credits to obtain the so-called net credit content of a curriculum.

Item 25. *Differential Equations and Other.* Ordinary differential equations and other mathematics over and beyond the usual differential and integral calculus are included here.

Item 32. *Other Chemistry.* This covers colloid, nuclear and electrochemistry, the chemistry of plastics, and other chemical specialties.

Item 35. *Modern Physics. Atomic Physics* and *Nuclear Physics* are course titles typifying material represented by this item.

Item 39. *Graphics.* This covers such course titles as *Engineering Drawing, Descriptive Geometry, Drafting,* etc.

Items 41 and 42. *Economics.* The broader courses in economics are placed in Item 41. Courses more specifically aimed at chemical plant operation and the economics of equipment plant and process design comprise Item 42. There is unavoidably some overlap.

Item 43. *Business Law, Business Administration, etc.* This is a catchall for courses in management, business administration, labor relations, accounting and items of business law; patent law, contract law, etc.

Item 45. *Mechanics of Solids.* This item represents one of the six engineering sciences listed by the ASEE Committee (loc. cit.).

Item 46. *Mechanics.* Statics, dynamics or both.

Item 47. *Mechanics of Materials.* This includes courses in mechanics of materials or strength of materials, the application of mechanics to simple problems of design of structural members. *Materials of Engineering,* the study of the production, applications and testing of engineering materials, is included under Item 57.

Item 50. *Elementary Electrical Engineering.* Credits included here cover courses concerned mostly with d-c and a-c circuits, fields, magnetic circuits, measuring instruments and machinery. Treatment of electronics is minor.

Item 51. *Elementary Electronics.* Material is included under this item when devoted mainly or completely to elementary electronics.

Items 53–57. *Materials Courses.* In deference to ASEE Committee discussion, courses relating to materials have been divided into two groups, A and B. Group A courses (Items 54 and 55) relate the properties of materials to "particle and aggregate structure" in terms of solid-state physics and chemistry. Group B courses (Items 56 and 57) employ a more pragmatic approach.

Typical titles of Group A courses are *Physical Metallurgy and Metallography, High Polymer Theory,* and *The Structure of Solids.* Typical titles of Group B courses are *Engineering Materials, Production and Application of Plastics, Engineering Metallurgy, Materials of Engineering.*

Item 59. *Supplementary Sciences and Practices.* This heading is a catchall for material not conveniently includable elsewhere and/or material currently considered by the majority to be supplementary or secondary training for the undergraduate chemical engineer.

Item 63. *Other.* Herein are included such items as surveying and structural design.

Item 66. *Material and Energy Balances.* The subject matter covered here is often offered under the title *Industrial Stoichiometry.*

Item 67. *Thermodynamics.* Usually chemical thermodynamics alone, but sometimes augmented by other thermodynamics courses.

Item 70. *Unit Operations Theory.* Currently interpreted to include courses in fluid flow and heat transfer, a confusion of terms.

Item 73. *Chemical Engineering Design.* By chemical engineering design is meant the design of chemical engineering machinery, plants and/or processes, requiring the application of unit operations theory, chemical process principles and economic analysis.

Item 74. *Chemical Technology.* The term *chemical technology* currently employed as

TABLE 2

THE HARD CORE CURRICULUM

Subject	National Average No. of Credits (From Table 1)
Item 9. Written Communication Skills	6.5
Item 24. Analytical Geometry and Calculus	11.6
Item 27. General Chemistry	8.0
Item 28. Physical Chemistry	8.5
Item 29. Organic Chemistry	8.5
Item 30. Quantitative Analysis	4.2
Item 34. General Physics	10.8
Item 39. Graphics	4.7
Item 46. Mechanics	3.7
Item 47. Mechanics of Materials	3.1
Item 50. Elementary Electrical Engineering	4.7
Item 66. Material and Energy Balances	3.8
Item 67. Thermodynamics	4.8
Item 70. Unit Operations Theory	7.6
Item 71. Unit Operations Laboratory	4.1
Item 73. Chemical Engineering Design	3.7
	98.3

a course title is broad and diffuse. Courses so titled cover such varied topics as the nature and peculiarities of chemical industry, the economic interrelationships between its various branches and with industry as a whole, flow sheets of outstandingly important chemical processes, chemical machinery, company organization and operation, chemical process calculations applied to the production of important products, factors of plant location, and still others. The treatment of content may be essentially descriptive or involve considerable calculation. Some typical course titles are *Chemical Technology, Chemical Processes, Chemical Industry, Industrial Chemical Processes, Industrial Chemistry, Chemical Engineering Technology.*

Item 75. *Investigational Skills.* This item embraces courses designed to develop the techniques for attacking and solving professional problems by formal discussion and idea interchange (seminar), library search (literature thesis), laboratory investigation (experimental thesis) or any combination thereof. Typical course titles are *Seminar, Thesis, Research, Special Problem, Library Practice.*

Item 76. *Introduction to Chemical Engineering.* Grouped here are courses designed to ease the transition from the pre-engineering curriculum to the rigors of the professional curriculum. The courses contain such items as simple material and heat balances, use of tools such as the slide rule and special coordinate paper, solution of elementary economic problems, construction and reading of graphs, plots, flow sheets, etc. To be classed here, courses must have a substantial content of such simple technical material. Otherwise they have been included in Item 19. Course titles include *Introduction to Engineering, Engineering Analysis, Chemical Engineering Fundamentals, Engineering Problems.*

Item 77. *Instrumentation.* This is a condensed title covering courses devoted to the measurement and control of process variables.

Item 79. *Trips.* Trips courses are only included in this study when they carry credit toward the degree. In some institutions students are required to take a course of this nature without credit.

Item 85. *Technical Electives.* All technical electives are included here. In those few cases where credit is assigned to "Electives" and the college bulletin gives no indication whether the elective material is technical or non-technical, half the credit is arbitrarily included here and half with Non-technical Electives, as explained above under Item 15.

Analyzing One's Own Curriculum

By applying the procedure and definitions established above, one may anaylze

one's own curriculum and, with the aid of Table 1, determine to what extent it conforms with or deviates from the "norm."

No case will be made here either for conformity or deviation. That there must be both is almost self-evident. Too little conformity, that is, too wide a spread in kind and amount of curriculum would imply the availability of "cheap" or "easy" degrees somewhere and would tend to rob the bachelor's degree of meaning. On the other hand, constructive change and progress can only be accomplished by pioneering trial and experimentation, which in turn cannot be accomplished except by deviating from the "norm," whatever that may currently happen to be. Finally, it might be well to remind ourselves that any large deviation from the current norm may be traceable to stagnation as well as to fermentation. It may indicate a lack of awareness or a reluctance to change with the requirements of the times.

The "Hard Core" Curriculum

If, as a matter of interest, one arbitrarily defines any subject offered in 90% or more of the accredited curricula as "indispensable," one may then tabulate the so-called hard core curriculum shown in Table 2.

This hard core represents 72% of the current net credit content. It so happens that there is a rather sharp line of demarcation between this arbitrarily defined hard core and the rest of the curriculum. It will be interesting to see how this hard core changes in the future, both quantitatively and qualitatively.

Comparison of High- with Low-Cultural-Percentage Curricula

From the 81 curricula that were surveyed to compile Table 1, two groups of eight have been separated. The first group consists of that 10% of the curricula highest in cultural course credits. This will be called the H-C-P group. The second group is comprised of that 10% of the accredited curricula lowest in cultural course credits, the L-C-P group. Averages have been calculated on these two groups with the results shown in Table 3.

A much discussed current recommendation of the ASEE Committee (p. 13 of the Report) is that "about one-fifth of the curriculum should be devoted to humanities and social studies." This may be interpreted to mean about 27.5 or about 29.5 ECPD credits, depending on whether one takes one-fifth of the average net credits or average gross credits. From the Report it is not clear whether English Communication Skills and Principles of Economics (Items 9, 10 and 41 of Table 1) are intended to be included in this fifth of the curriculum. Nor is it made clear that the intention is to rule them out. Nevertheless, the figures in Table 3 indicate that the H-C-P group happens to have a cultural content rather close to the ASEE Committee's recommendation.[2] The cultural course content of the L-C-P group, on the other hand, is well below the current average for accredited curricula. From Table 3 the indicated difference of 19.5 credits in Item 16 between the two groups is substantial. The purpose of this comparison will be to ascertain, in a sense, what is removed from the curriculum when the cultural content is increased to the extent recommended by the Committee and in what important areas, if any, the curriculum suffers serious attrition or damage.

Examination of the bulletins of institutions in the H-C-P group showed that of the 11.1 credits of non-technical electives in Item 15, Table 3, about two could readily represent work in communication skills and another three or four credits in the study of economics, particularly Item

[2] One accredited institution recently underwent a periodic review by accreditation agencies. The curriculum currently contains:

Item 6. Gross Credits	145
Item 7. Net Credits	141
Item 11. Communication Skills	7
Item 12. Humanities	6
Item 13. Social Studies	9
Item 16. Total, Cultural	15
Item 41. Principles of Economics	0

The accreditation agencies recommended that "the humanistic-social stem be increased by about six credits."

TABLE 3

COMPARISON OF HIGH-CULTURAL-PERCENTAGE CURRICULA WITH LOW-CULTURAL-PERCENTAGE CURRICULA

Item	Subject	Highest Cultural Percentage Group Average Number of ECPD Credits Column 1		Lowest Cultural Percentage Group Average Number of ECPD Credits Column 2		Difference. Column 1 Minus Column 2	Item
6.	Gross Credits		147.3		147.0		6
7.	Net Credits		137.8		137.9		7
8.	Non-technical Subjects						8
9.	Written Communication Skills		4.6		7.8	− 3.2	9
10.	Oral Communication Skills		0.4		1.3	− 0.9	10
11.	Subtotal, Communication Skills	5.0		9.1		− 4.1	11
12.	Humanities, Required Courses		6.9		2.1	+ 4.8	12
13.	Social Studies, Required Courses		6.6		1.2	+ 5.4	13
14.	Other Required Cultural Courses		1.5		0.9	+ 0.6	14
15.	Non-technical Electives		11.1		2.4	+ 8.7	15
16.	Subtotal, Cultural Course	26.1		6.6		+19.5	16
17.	Physical Education, etc.		1.8		1.9	− 0.1	17
18.	Military Studies		4.1		1.2	+ 2.9	18
19.	Other Non-technical		0.2		0.5	− 0.3	19
20.	Subtotal, Physical, Military, etc.	6.1		3.6		+ 2.5	20
21.	ALL NON-TECHNICAL SUBJECTS, TOTAL		37.3		19.4	+17.9	21
22.	Mathematics, Chemistry and Physics						22
23.	Introductory & Review Mathematics		3.4		5.5	− 2.1	23
24.	Analytical Geometry & Calculus		11.5		11.6	− 0.1	24
25.	Differential Equations and Other		0.4		1.1	− 0.7	25
26.	Subtotal, Mathematics	15.3		18.3		− 3.0	26
27.	General Chemistry		8.3		8.1	+ 0.2	27
28.	Physical Chemistry		8.0		8.5	− 0.5	28
29.	Organic Chemistry		8.4		8.4	0.0	29
30.	Quantitative Analysis		4.1		4.1	0.0	30
31.	Qualitative Analysis		1.4		0.8	+ 0.6	31
32.	Other Chemistry		0.4		0.3	+ 0.1	32
33.	Subtotal, Chemistry	30.5		30.1		+ 0.4	33
34.	General Physics		11.3		11.4	− 0.1	34
35.	Modern Physics		0.0		0.4	− 0.4	35
36.	Subtotal, Physics	11.3		11.8		− 0.5	36
37.	MATH., CHEMISTRY & PHYSICS, TOTAL		57.0		60.1	− 3.1	37
38.	Engineering Graphics						38
39.	GRAPHICS, TOTAL	3.5	3.5	5.4	5.4	− 1.9	39
40.	Economics, Business Law, Business Administration and Allied						40
41.	Economics, Principles of		0.4		4.5	− 4.1	41
42.	Economics, Engineering		0.6		1.0	− 0.4	42
43.	Bus. Law, Bus. Admin., etc.		0.0		1.8	− 1.8	43
44.	ECO., BUS. LAW, BUS. ADMIN., TOTAL		1.0		7.3	− 6.3	44

TABLE 3—(*Continued*)

Item	Subject	Highest Cultural Percentage Group Average Number of ECPD Credits Column 1		Lowest Cultural Percentage Group Average Number of ECPD Credits Column 2		Difference, Column 1 Minus Column 2	Item
45.	Mechanics of Solids						45
46.	Mechanics		3.8		4.0	− 0.2	46
47.	Mechanics of Materials		2.4		3.4	− 1.0	47
48.	MECHANICS OF SOLIDS, TOTAL		6.1		7.4	− 1.3	48
49.	Elementary Electrical Engineering						49
50.	Elementary Electrical Engineering		4.9		5.0	− 0.1	50
51.	Elementary Electronics		0.0		0.0	0.0	51
52.	ELECTRICAL ENGINEERING, TOTAL		4.9		5.0	− 0.1	52
53.	Nature and Properties of Materials, A and B						53
54.	Physical Metallurgy		1.4		1.6	− 0.2	54
55.	Other Category A Courses		0.0		0.3	− 0.3	55
56.	Metallurgy		0.4		0.4	0.0	56
57.	Other Category B Courses		0.1		0.1	0.0	57
58.	MATERIALS, TOTAL		1.9		2.4	− 0.5	58
59.	Supplementary Sciences and Practices						59
60.	Biology and Geology		0.0		0.3	− 0.3	60
61.	Heat Power		0.1		2.5	− 2.4	61
62.	Shop Practice		0.0		0.4	− 0.4	62
63.	Other		0.0		0.6	− 0.6	63
64.	SUPPLEMENTARIES, TOTAL		0.1		3.8	− 3.7	64
65.	Chemical Engineering						65
66.	Material and Energy Balances		4.8		4.1	+ 0.7	66
67.	Thermodynamics		5.3		4.6	+ 0.7	67
68.	Chemical Kinetics		0.4		1.1	− 0.7	68
69.	Subtotal, Chem. Process Principles	10.4		9.8		+ 0.6	69
70.	Unit Operations Theory		7.3		7.9	− 0.6	70
71.	Unit Operations Laboratory		4.1		3.4	+ 0.7	71
72.	Unit Operations, Subtotal	11.4		11.3		+ 0.1	72
73.	Chemical Engineering Design		2.9		4.6	− 1.7	73
74.	Chemical Technology		2.8		2.6	+ 0.2	74
75.	Investigational Skills		4.4		2.9	+ 1.5	75
76.	Introduction to Chemical Engineering		0.3		1.0	− 0.7	76
77.	Instrumentation		0.0		0.3	− 0.3	77
78.	Unit Processes		0.3		0.8	− 0.5	78
79.	Trips		0.2		0.0	+ 0.2	79
80.	Fuels and Lubricants		0.0		0.5	− 0.5	80
81.	Other		0.1		0.3	− 0.2	81
82.	Subtotal	11.0		13.0		− 2.0	82
83.	CHEMICAL ENGINEERING, TOTAL		32.6		34.0	− 2.6	83
84.	Technical Electives						84
85.	TECHNICAL ELECTIVES, TOTAL	3.0	3.0	2.4	2.4	+ 0.6	85

41. Hence, in comparing the figures in Table 3 one should realize that the disparities between the H-C-P and L-C-P groups with regard to Items 11, 16 and 44 (Subtotal, Communication Skills; Subtotal, Cultural Courses and Total, Eco., Bus. Law, Bus. Admin., etc.) may not be as large in fact as they appear from the numbers in the table. It is nevertheless apparent that the large increase in cultural content represented in the H-C-P group is accompanied by sizable reductions in Items 44 and 64 and more modest reductions in Items 37, 39, 48 and 83.

It is interesting to note that most of the loss in Item 37 (Mathematics, Chemistry and Physics) stems from a reduction in credit given for the study of algebra and trigonometry, and that the loss in Item 83 (Chemical Engineering) occurs outside the realm of chemical process principles and unit operations.

The reductions in Items 11 and 23 (Communication Skills and Introductory and Review Math) could be interpreted as an insistence that the three R's be taught and mastered in high school, not in college with credit toward an engineering degree.

Finally, from a study of Tables 1, 2 and 3, it is probably safe to admit that the cultural content of the average accredited Ch.E. curriculum of 1956–57 may be increased by six ECPD credits without exerting undue or irreparable violence upon it.

Discussion of Table 1

As previously noted, the ASEE Committee recommends that "about one fifth of the curriculum should be devoted to humanistic and social studies." Referring to Gross and Net Credits, Items 6 and 7 of Table 1, this could mean one fifth of anything from 118 to 160 credits, depending upon individual curricula and individual interpretations. Also, as previously noted, the Committee does not make clear whether or not English communication skills and principles of economics are to be included as part of the recommended one fifth of the curriculum. These subjects have an average value of 9.8 ECPD credits (Items 9, 10 and 41 of Table 1).

As a consequence of these ambiguities, in one actual case of an institution whose 1956 curriculum is on the low side in cultural content, two reasonable but different interpretations indicate that as few as 9 credits or as many as 20 credits of cultural subjects would have to be introduced to bring this particular curriculum up to the indicated one fifth in humanistic and social studies. Taking due recognition of the fact that a committee offering suggestions on a subject such as curriculum revision would make a mistake in attempting to pinpoint its recommendations, the recommendation under discussion is still too vague to serve as a truly satisfactory working maxim.

Mathematics in the realm of differential equations and beyond (Item 25, Table 1) is an area where the current curriculum is obviously weak in the eyes of the Committee, which believes that "ordinary differential equations and their application to the solution of physical problems lie close to the boundary of minimum acceptability of mathematics in any satisfactory engineering curriculum." It will be seen that somewhat less than half of the accredited curricula include such material.

Only 8.6% of the accredited curricula include a required undergraduate course in modern physics (Item 35). The Committee has strongly urged such inclusion.

Credit devoted to electronics is shown as a separate item (Item 51) in Table 1 to offer some measure of the extent to which this subject is included in current curricula in light of the Committee's feeling that it should be an integral part of all engineering curricula. About one tenth of the accredited curricula have courses which deal wholly or substantially with electronics.

In Table 1, courses devoted to materials are divided into two groups, A and B. The Committee lists "Nature and Properties of Materials (relating particle and aggregate structure to properties)" as one of the six main branches of engineering science (p. 14 of the Report). It recommends inclusion of courses deal-

ing with this subject. The recommendation is accompanied by the provocative statement that "forward-looking engineers are searching the recent advances in solid-state theory and chemistry for an entirely new and fundamental scientific approach to the study of the behavior of materials. This field appears to be almost ready for engineering conquest and its development will bear very close watching by engineering educators."

Group A courses approach the study of materials from the viewpoint indicated as desirable by the Committee (see definitions of Items 54–57 of Table 1). If this area is as important as the Committee seems to feel, the current curriculum is particularly weak here. Less than half the accredited curricula include courses in physical metallurgy and only two contain required courses in high polymer theory or solid state physics.

GRADUATE CO-OPS AT CINCINNATI

A new experiment in cooperative education—combining graduate studies and research in engineering and the physical sciences—was initiated this fall at the University of Cincinnati in its College of Engineering and Graduate School of Arts and Sciences. This extension of cooperative education will combine study for master's and doctor's degrees with basic research under fellowships sponsored by industry.

Doctorates in physics and chemical and metallurgical engineering will be offered first. It is hoped the program may be expanded later into other areas.

NEW MATHEMATICAL FUNCTIONS SERIES AVAILABLE

A series of new mathematical functions based on the repeated indefinite integrals of Cauchy's function $e^{-(1/x)^2}$ and the function $e - p^2\cot^2 x$ (e being the Naperian base) has been constructed by David Briansky, a consulting engineer. He says that these functions quite flexibly represent curves for magnetic saturation, electron flow, fluid viscosity, deformation of material, fatigue of material, thermal stresses, chemical and electrochemical reactions, and other phenomena. The functions are suitable for two and three dimensional representations.

Mr. Briansky is willing to share the results of his researches without fee. Correspondence should be addressed to:

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Bronx 63, New York

EXPERIENCE IN TEACHING THERMODYNAMICS AND FLUID MECHANICS AS AN INTEGRATED COURSE

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If we examine the responsibilities of engineering educators for the immediate years ahead, we become aware of several severe challenges. We must digest and organize for presentation a body of knowledge that is increasing in amount and complexity at a rapid rate due to large scale international political forces. These acts of digestion and integration must be so efficient that the imaginative student may continue to be ferried to the frontiers of knowledge well before his peak of creativeness has been reached. At the same time, we must expand our facilities and orient our programs to cope with a rapidly growing number of students who will seek training. As a partial response to these challenges we present arguments for integrating elementary fluid mechanics and thermodynamics.

Integration, by definition, is the act of making whole. Thus it is proposed that these two general purpose courses, taught separately, are less intelligible than when presented in combined form. Let us briefly expose the evidence that leads to such a conclusion.

There are many subject areas which require the principles of fluid flow and thermodynamics: heat transfer, aerodynamics, turbo machinery, power plants, and propulsive systems. Here one finds the principles of fluid mechanics and thermodynamics so inextricably related that they are more and more frequently presented as a unified set of tools for attacking problems. Engineering educators associated with aeronautical courses and companion gas dynamics courses were the first to recognize this interdependence. This evidence strongly suggests that the elementary courses may have much in common.

Fluid mechanics, by definition, is that branch of physical science which deals with the motion of fluids. It is concerned with the storage and transmission of fluids, and the forces they exert on other bodies. When a fluid moves, energy is involved; and the laws of thermodynamics can constitute some of the most powerful tools for analyzing this motion.

Engineering thermodynamics is the study of the storage, transmission, and transformation of energy. In the majority of thermodynamic systems of interest to the engineer, the working substance is a fluid. That is, it is a fluid to which energy is added, within which it is transformed and from which it is extracted.

Points in Common

From these definitions it becomes increasingly apparent that the two courses have a great deal in common. One is a study of fluid transportation and storage and the energy associated

with these acts. The other is a study of energy transformation, storage, and transmission, where the principle substance of interest is a fluid.

Let us inquire into some of the basic details of the subject areas for further arguments.

The physical properties of matter common to both courses are extensive. Some are: pressure, temperature, density, viscosity, coefficients of compressibility and cubical expansion, velocity, surface tension, enthalpy, and internal thermal energy. If the courses are separate, and taught from separate texts, these properties are often presented with conflicting emphasis, dimensions and notation. Further, the property, entropy, which should be common to both areas, is not so presented.

The concepts of state and process as well as the concept of a continuum are common to both subject areas, yet the frictional processes of fluid mechanics are rarely associated with the irreversible processes of thermodynamics. Head loss is seldom identified as a transformation and degradation of energy. The student frequently comes to the conclusion that energy is destroyed in a frictional process. He can benefit if this confusion is eliminated.

The shifting of our point of observation from an element of matter to a boundary in space is an important operation in both subject areas, yet it is difficult to find both a fluid mechanics and thermodynamics text that use the same method and notation in performing this transformation.

Work associated with flow processes is an important and common term to both subject areas but it is difficult to find the term adequately discussed in elementary fluid mechanics texts and to expect the beginning student to see the equivalence in any pair of texts is asking for an insight that he does not generally possess.

A very serious shortcoming arises when physical principles are considered. The physical principles that are, or should be, introduced and drawn upon for evaluation and explanation of many processes common to both subject areas are currently isolated by the segregation of the two subjects. Classically, fluid mechanics texts emphasize Newton's Laws of motion, and the conservation of matter principle. Authors frequently evolve an energy principle from this approach with the result that the "total energy" of a fluid stream neglects thermal energy. The first law of thermodynamics may be touched upon, but too frequently its utility in explaining where energy resides is not exploited. The second law of thermodynamics is generally ignored in fluid mechanics texts. As a result, there is no way of identifying the direction of spontaneous processes. As an example, entropy can conveniently be used to show that the opposite of the hydraulic jump cannot occur; but this is seldom done.

If we examine the indicies of a cross-section of elementary thermodynamics texts, we are startled to realize that the majority do not list Newton or his laws nor do they list momentum or impulse. Yet, the majority list impulse turbines of the steam variety. This is incongruous. Can the torque imparted to the stationary turbine wheel be determined from the state changes of the fluid passing through it by use of the first law of thermodynamics? It cannot, but Newton's equations of motion will yield the answer. If the prediction of torque is desired when the wheel is in motion, application of the impulse-momentum principle usually allows the most direct approach to the problem.

The Experiment

These arguments, and many others, coupled with the eternal argument about which course will come where in the curriculum, led us to experiment with an integrated course. The course is a one year junior level course consisting of lectures and laboratory. It is designed to present a digestible mixture of properties, property relationships, principles, and processes. It starts with basic concepts and simple systems, and builds continuously to the evaluation of mixtures of substances experiencing complex processes.

Initially the fixed mass system is dealt with in solid, liquid, and gaseous form in the rest state. This simple system permits an introduction to many important properties and property relationships as well as to Newton's equations of motion and the first law of thermodynamics. The fluid phases of matter are reinvestigated under the conditions of simple motion. After a discussion of the concepts of streamlines, and laminar and turbulent flow, Euler's equations of motion are derived. The point of view now shifts from the observation of a fixed element of matter to a fixed boundary in space. The mathematical expressions of the conservation principles of matter, momentum and energy are transformed to this new frame of reference. Elementary problems dealing with pipe flow, jets, pumps, turbines, propellers, and heat exchangers are thoroughly investigated in order to consolidate the student's understanding of these principles and make him more aware of the degradation of energy. At this point the second law of thermodynamics is introduced, the property entropy is discovered and a thorough discussion of property relationships for all of the phase regions is carried on. The fixed mass and bounded space systems are reconsidered with further insight into their process and cycle behavior.

It is believed that the material presented thus far is the minimum core material; that is, the material which all engineering students should recognize and be able to handle with proficiency. However, time is still available for applying this material in an introductory way to:

(a) incompressible and compressible flow processes in both constant and variable area ducts.
(b) refrigeration and heat power systems.
(c) air conditioning processes and to combustion.

Added relationships, definitions, and techniques are presented with these topics.

Since the laboratory runs concurrently with the lecture, it has been found ideal to start with experiments which permit the introduction of dimensional analysis. This allows the student to deduce generalized relationships which he may subsequently derive in the class room. The approach shows him the power of dimensional analysis when his ability is inadequate to derive a generalized solution to a problem. Yet, this approach can be made at this point with relatively elementary experiments such as determining the pressure drop for laminar flow in pipes, or the pressure drag coefficient for a simple aerodynamic flow configuration.

After several experiments of this type, the lecture material is sufficiently advanced so that the laboratory can be oriented to support and expand the material being presented in the lecture.

In the senior year, mechanical engineers are expected to expand their basic and applied knowledge in these areas through additional courses. Civil

engineers take a subsequent course in hydraulic engineering, and electrical engineers extend their background in this area through a course in heat transfer.

We have presented some of the arguments why elementary engineering thermodynamics and fluid mechanics should be integrated. We believe that we have been successful in accomplishing the change at the University of Santa Clara. We are of the opinion that the students are able to make a more logical approach to solving problems in this area as a result of the integration. We are convinced that they are better prepared to enter courses in aerodynamics, propulsion systems, advanced fluid mechanics, and heat transfer; but perhaps the best evidence of whether the course integration is correct or not is the fact that none of the instructors who have presented the integrated course have any desire to return to the old system.

Our conclusion is that integration of elementary engineering thermodynamics and fluid mechanics allows a more efficient presentation of these subject areas with the result that a more comprehensive appreciation is acquired by the student for the time invested.

NEW RADIO TELESCOPE AT MICHIGAN

The University of Michigan's 85-foot-wide steerable radio telescope is nearing completion.

Completion date of the 10-story-high antenna structure was mid-October, says Prof. Fred Haddock, director of the radio telescope project, which is being administered by the Departments of Astronomy and Electrical Engineering.

Haddock expects the dish will be in full operation no later than early next spring. Total cost of the facility, which is situated atop Peach Mountain 16 miles west of Ann Arbor, will amount to $300,000, most of which is being supplied by the Office of Naval Research. When completed the dish will stand nearly 1,100 feet above sea level and will operate day and night, weather permitting.

The telescope also will provide a training and research facility for faculty and students in the relatively new field of radio astronomy.

The new dish is the second radio telescope erected atop Peach Mountain. In August, 1957, a 28-foot wide unit for solar observations was placed there, and already it has provided "new and unusual" signals from the sun.

FRESHMAN ENGINEERS AT COLUMBIA

Columbia University's School of Engineering opened its doors to freshmen this Fall for the first time since 1914.

A small group of highly qualified graduates of secondary schools began the new undergraduate program leading to a bachelor's degree in Engineering. It will constitute the first freshman engineering class in 45 years.

Through the years the entering class is expected to grow to a maximum of 200.

CONSULTING PRACTICE FOR PROFESSIONAL DEVELOPMENT

of the Young Engineering Teacher

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Recommended by the YET's

When we speak of professional development of the engineering teacher, we think primarily of two aspects: development as an engineer and development as a teacher.

For the instructor to become an engineer able to teach engineering successfully, he must *practice*—not read about—*true engineering* with all of its complexes of theory and guesses, of experience and probabilities, of human relations and costs and deadlines! He must come to realize that engineering means getting the most out of things and people as they actually are—not as theory would have them be.

For the student to learn engineering, he must see and come to respect that part of his instructor's experience and capability which advertises—"Engineer." The student must learn (and by inference, therefore, must be taught) the general application of scientific knowledge to practical facts concerning the production of the material things of life. His mind must become accustomed to the fact that real things are always less than perfect, and that responsibility for quantities of someone else's dollars is usually involved in his professional decisions. He must come to realize that "part-credit" is seldom granted in the examinations of real life.

Objective considerations should tell us that we do not provide a valid illustrative example of engineering to our students solely by our participation in research or in pursuit of advanced degrees! In contrast, the real catalyst for successful engineering education is the practice of actual engineering by the engineering teacher. With this practice, too, will come true professional development, marked by recognized success both as an engineer and as a teacher.

The method of gaining such practical experience is by participation in part-time employment or consultation assignments with engineering firms, and following problems through to their conclusions—through all the muck, mire, routine, and glory involved.

Where can the engineering educator get the time? He can generally find between 10 and 20 hours per week of overtime for such efforts. Of course, some of the those hours may have to be borrowed from his family, and others from casual student contacts. In part, too, many engineer schools now do, and more certainly should, recognize the value of such professional practice on the part of their engineering faculty. The investment is a rewarding one, with substantial returns in both professional development and in general knowledge of what the score really is.

How about money? There is money to be made by such activities. When you have something to contribute to industry, industry gains by use of your services for a proper pro-

fessional fee. This is an ideal way to share and extend faculty skills and productivity without leaving teaching, without robbing staffs, and without competitive conflict. Further, once recognized as a proper procedure, this is a splendid way to bridge the gap between the true economic worth of a faculty member and the inadequate funds usually available to pay for his teaching.

Must you specialize? Sprouting from your chosen area of knowledge, you will find contacts with a surprisingly large array of relevant information from other fields, seemingly remote from yours. For instance, the civil engineer can learn much from developments in the electrical field, and *vice versa*. You will find that normal communication between the various technical fields is actually very poor, but that consulting work at high levels will increase both your intake and outflow of information. Your specialty turns out to be both the key to and your initial offering for entrance into fresh and new areas of technical interest.

Let us remember that we in education are both engineers and teachers. Our professional development as engineering teachers must involve the practice of engineering, otherwise it may be considered as less than complete and our contributions to our students must be less than the best.

This writer and many of his associates are currently concerned over the general trend in engineering education away from this qualification of practical experience. It is our opinion that this is a mistake which the engineering profession may pay a heavy price for before correction. But that should be the subject of another paper.

NEW PROFESSORSHIPS AT NORTH CAROLINA STATE

The North Carolina Engineering Foundation has announced plans to finance the establishment of seven distinguished professorships in the School of Engineering at North Carolina State College.

Edwin A. Clement of Raleigh, president of the Foundation, said the professorships—designed to retain and attract top-ranking teachers and scientists for service in the State College School of Engineering—have been authorized by the Executive Committee of the Board of Trustees of the Consolidated University of North Carolina. Establishment of the professorships will enable the college to provide substantial supplements to the State salary scale for the employment of a core of outstanding engineering educators.

Since it was organized in 1944, the Engineering Foundation has provided financial support to the college's School of Engineering. The professorships are a further extension of this support. Dr. J. Harold Lampe, dean of engineering at the college, declared, "This is another outstanding contribution of the Engineering Foundation in its continuing effort to stimulate and encourage our faculty."

Candid Comments

Performance or Panic

The reading of Professor Alpern's Candid Comment "Proficiency or Panic" in the March 1959 JOURNAL impels me to comment in return. Perhaps a suitable title for my comment would be "Performance or Panic."

My concern is with the fate in industry of the engineering graduate who has been educated in an institution using the "no time limit" theory of examinations. Very soon after graduation he is most likely to face an engineering task which even the most rapid and able of his examination-taking classmates would be unable to "finish" in the time allotted. Yet the best possible engineering answer must be provided, with all his superiors breathing down his neck in a manner quite superior to that achieved by most college examiners. If our recently graduated friend has during his college career not been required to turn out his jobs under pressure of a time limit, how is he to react to a greater pressure in many industrial problems?

In practice it is seldom that the solution of engineering problems can be carried to perfection. Either the rush to beat the economic or political competitors, or the budget, forces a decision at some point that the result is adequate, and the job must be terminated to make way for the next one.

Certainly one job of the engineering school is to insert into the students' heads adequate engineering knowledge. Should not a companion responsibility include at least a start on training in the methods of thinking required to extract that knowledge in the environment the students will meet after graduation? One might even argue that examinations should be so designed that even the best of the students could not finish all the details, but also so designed that there was opportunity for engineering judgment by the students in deciding which aspects of the problem were most important within the time allotted. In this concept the examination would be a training tool as well as a measuring tool.

There are no doubt many jobs where the pressure of time is not a large factor in the performance of the engineer. If we wish to improve the examination as a measuring tool, it could be arranged that the student would face both "time unlimited" examinations and severely time limited examinations. If the results from both types were kept separately, it should be possible to determine which students could best work under pressure, and which the poorest. Those who panic under pressure could then at the start of their career be guided toward jobs tolerating that characteristic.

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This section is open to those of our readers who have brief comments to make on articles in the JOURNAL *or on engineering education in general. Send your comments to the Editor,* JOURNAL OF ENGINEERING EDUCATION, *University of Illinois, Urbana, Illinois.*

Foreign Language for the Engineer

Mr. Knight Pryor's article, "Foreign Languages in the Humanities Program," in the March, 1959, issue of the JOURNAL seemed to me to take an overly pessimistic view of the possibility of language study for the engineering undergraduate.

It is true, of course, that the engineer's program, especially in the four-year curriculum, is a very crowded one. This means that a language teacher cannot fairly ask that his college institute an eight- or ten-hour course, with a labora-

tory and pattern drill, of the type that has proved so successful at many liberal arts schools. He may even feel, as some of us do at Michigan Tech, great reluctance to ask for a four-hour course, because the criticism may be made of all engineering curricula that they require too much time in class and the teacher is unwilling to add to this burden.

Obviously a language course which meets three times a week for a year can give the student some ability to read, but little or no facility in the spoken tongue. In French, where the problem of pronunciation is especially acute, the lack of time is most discouraging to teacher and student both: the student with a slow ear may still be a latter-day version of Chaucer's prioress at the end of the course.

If we cannot take more of the curricular time, then, it might be wise to look at the extra curricular time. But here, too, the picture is discouraging: most of our students belong to an undergraduate professional society, play in some intramural sport, and have some (minimal) social life; this means that most have no more than four free evenings a week, if that.

There is only one possible conclusion, it seems to me: we must fit language study in here and there, at odd moments of the day, whenever there are ten or fifteen minutes available. And here again we know that there is but one way of accomplishing this objective, namely, establishing a *Maison française*, a *Deutsches Haus*, a *Casa española* on the campus. We have the student in such a residence for some of his leisure time, for meals, and perhaps too for some of his social engagements. It affords a completely painless way to learn, the cost is comparatively low, the student develops a vocabulary far wider than that acquired solely through reading, and, finally, along with vocabulary and experience in conversation, the student becomes confident about his fluency. (Every student I have ever seen who has lived in a foreign-language house for two years or more has shown a real command of the particular language.)

So, it seems to me that any engineering college has nothing to lose and much to gain by setting up such a program.

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Department of Humanities and Social Studies
Michigan College of Mining and Technology

ROTC in Engineering Curricula

The National Commission on Accrediting has prepared and distributed a memorandum, dated July 5, 1957, for Presidents of Colleges and Universities with ROTC units. The memorandum concerns the merit or advisability of granting academic credit toward an engineering degree for ROTC course work. The Commission, in the memorandum, purports to take no stand on the matter but merely sets forth an issue which, they say, has been compromised and put off many times in the past, but which must now be faced for positive, definitive action.

The matter seems to have been brought to a head by the Naval ROTC program under which "Contract" students may work toward degrees in engineering and at the same time toward commissions in the U. S. Naval Reserve. The problem is acute in the Air Force and Army ROTC programs also. Inasmuch as there has been, and no doubt will continue to be, heavy pressure to strengthen both the technical and cultural sides of many engineering curricula, without increasing the elapsed time required for a student to complete such curricula, there is corresponding heavy pressure to "find" hours in some other area. Although the policies of the various engineering schools and colleges throughout the country vary from that of granting no credit for ROTC work to that of granting full credit for each hour of ROTC work taken, there is pressure to reduce or eliminate credit

granted for such work or to reduce or eliminate the ROTC work itself. Where credit is granted, it is frequently looked upon as a ripe plum ready for plucking.

At the request of the Engineer's Council for Professional Development, the Committee on Evaluation of Engineering Education of the American Society of Engineering Education prepared a report which bears on this problem. Quoting in part from the ASEE report:

"The Engineering Colleges recognize their obligations to the nation to train, through the mechanism of ROTC, a supply of future officers for the Armed Forces. It is believed that this should be accomplished without compromise with the basic educational concept developed in this Report. . . .

"The Committee on Evaluation recommends that no credit be allowed for advanced ROTC courses as a substitute for engineering courses. The Committee also looks with apprehension upon appreciable substitution of ROTC credit for humanistic and social studies. Although the context of certain ROTC courses may involve geography and government, fundamental differences exist between these courses and those offered in the humanities and social sciences.

"The major differences in course objectives, course organization, and qualification of instructors are valid reasons why the ROTC courses generally cannot contribute in a major way to the professional and liberal education of an engineer as do other courses in the curricula. Ideally, no substitution of ROTC credit should be allowed either for engineering courses or for those in the humanities and social studies. *As a practical matter it is urged that substitution for advanced ROTC credit for humanistic and social studies alone should not exceed one quarter of the total credit allotted to this area.* Experiences in a wide range of institutions demonstrate that the advantages to the student of ROTC training are sufficient to attract his enrollment without diluting his professional and cultural education through granting academic credit for ROTC beyond the amount proposed."

The last statement from the report is offered without reference. Unless and until confirmed by an objective analysis of actual enrollment records which would reveal a correlation, if it exists, between ROTC participation and credit granted for ROTC work, the statement strains one's credulity. The far more likely circumstance is that the student is directly influenced not only by the proportion of credit granted for ROTC work elected, but also in the more subtle influence of the implied stature and significance of ROTC as characterized by the ratio of credit granted to work actually taken in the ROTC program. If no credit is granted for ROTC work, the student would certainly tend to assume the work was of no value, and on an absolute scale, not just with respect to engineering. The report recommends what is plainly another compromise with the very broad hint that the compromise will serve until the "ideal" situation can be achieved wherein no credit will be allowed for ROTC work toward an engineering degree. Fortunately, as the report brings out, the engineering colleges recognize their obligations to train men for service as officers in the armed forces. Evidence is lacking of recognition of such responsibility by the authors of the report.

This responsibility is not something which should be taken for granted or accepted without question. Fortunately, it can be detailed and supported simply and cogently. It is abundantly evident that in a society or group of societies, all of which require police protection at virtually every stratum of organization, the nations themselves must be prepared for self defense. If a nation rises to that challenge at all, it will have an armed force characterized by one of three

conditions: (1) The armed forces will have a professional core dedicated more to militarism and their own self preservation than to the preservation of the country which it ostensibly serves. (2) The armed forces will be predominantly "citizen" in their make-up through an effective reserve program and administrative safeguards to ensure that the armed forces are responsive to an enfranchised citizenry. For such a characterization to be valid, a substantial percentage of the people of a country must be prepared and willing to accept military duty as necessary. (3) The armed forces can exist in being but without pride, sense of mission or will to serve.

Of course these are points in a spectrum but almost every armed force in the world or in history could be positioned in the spectrum within reasonably close limits. It should hardly be necessary to argue the point that the Armed Forces of the United States should be in the middle of the spectrum. If this premise is granted, then one is quickly and inexorably brought to the conclusion that our colleges and universities must do an effective job of training young men for reserve service in the Armed Forces. The young men must not only be trained but a reasonable percentage of the most capable must be encouraged to accept ROTC assignments.

All of this is not in the least an argument to grant credit for non-college work. The ROTC work outside of drill and rifle range work can, and must be, of college nature, and worthy of credit granted. There need be no compromise in this affair. The nub of the controversy seems to be whether training in international relations, geopolitics, history with a military emphasis can constitute course work in the "humanistic-social" area and apply toward a degree in engineering. When one considers that expenditures for military purposes constitute the largest single item in the budget of the United States, that military stature frequently determines the destiny of nations, that the United States has been engaged in war for 10 out of the past 50 years, that war, its prevention, or successful prosecution has direct and substantial influence on the lives of nearly all citizens of countries involved, it is readily apparent that ROTC course work of the aforementioned nature is certainly of a humanistic-social nature.

As part of the same memorandum, Professor George A. Gullette, Head, Department of Social Studies, North Carolina State College, is quoted, in part: "Despite this high quality (of ROTC courses in military history, geography, etc.), we have serious reservations about encouraging this practice (substitution for humanistic-social courses). First, the instructors in the military courses are neither permanent nor equally capable of teaching at the college level. Some of them could qualify as members of any college faculty, others could not. Second, the purpose of the military courses is to train officers, and classes are seldom conducted in an atmosphere encouraging to the free exchange of ideas, an atmosphere that is indispensable to the attainment of the objectives we have in mind. Finally, the rigid control exercised by military authority over the subject matter and examinations is out of the hands of the academic faculty. We doubt the wisdom for any faculty of allowing itself to be maneuvered into a position where it approves degrees earned through taking courses over which it has no effective control."

It could be said, in reply to Professor Gullette, that if the schools exercise no effective control of the ROTC course work, it is a fault at least in part of their own making since each ROTC unit is represented by a con-

tract between school and branch of the military service involved. Perhaps no one school could dictate effective control but certainly a substantial group of schools determined to see that, by contract, academic standards are maintained for ROTC work, would be effective. The military services are currently showing an eagerness to reach a satisfactory agreement with the schools on this very point. There is no need for the schools to tolerate unqualified ROTC instructors or inferior course work and in fact it is an adverse reflection against a school if this is tolerated. There is every likelihood that the military services would agree to select only properly qualified personnel for duty with ROTC units. This would not be an insurmountable problem for the military services. It is also probable that the services would willingly, in fact eagerly, submit ROTC syllabi to a review body representing the schools for their approval.

Regardless of the intentions of the schools, a continuing attack on ROTC which has the effect of reducing its stature in the eyes of the student may have a gravely dangerous influence on world affairs. It is probable that the noted British philosopher, C. E. M. Joad,* had motives just as pure as the academic critics of ROTC when he developed his ardent and vocal group of pacifist followers at Oxford just prior to World War II. Yet that very behavior was just the sort of stimulus needed to encourage Hitler in his adventure of world conquest.

For a final point, the primary purpose of our military force should be to maintain the peace, and with the proper type of armed force, there is good likelihood that it will be maintained. But we must face up to the possibility that war might come. At first glance, it might appear that modern, total war would be of such catastrophic nature that military training of the sort given in ROTC would be completely futile. Such appearances are deceiving. The job of survival under attack and reestablishing effective government has rarely been carried out satisfactorily except by military personnel. A striking example of civilian conduct under extreme duress occurred during the siege of Wake Island by the Japanese early in WW II.† It was apparent to the battalion of Marine defenders that they were woefully weak in the face of the upcoming attack and they looked to a civilian construction labor force for support in moving supplies. The civilians were so unnerved by the attack that they had to be confined to the brig to prevent their impeding the defense of the island. If war comes it may be that the winner will be the first country to successfully restore civil government. At such a point the results of an effective working agreement of considerable duration between the military services and the colleges and universities of the country, would be of prime value. Like insurance after the accident, it would be too late then to take out a policy.

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* Winston S. Churchill, *The Gathering Storm.*

† Samuel E. Morrisson, *The Rising Sun in the Pacific.*

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New Individual Members

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BEALE, LUTHER A., Professor and Head of Civil Engineering, Lamar State College of Technology, Beaumont, Texas. 1959.
R. V. Andrews, George Tims. C. E.

BEAM, WALTER R., Manager, Microwave Advanced Dev't, RCA Laboratories, Princeton, New Jersey. 1959.
Walter C. Johnson, Norman J. Sollenberger. E. E.; Admin. Ind.

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RAMMER, JOSEPH S., Chief Engineer, Heath Company, Benton Harbor, Michigan. 1959. W. Leighton Collins, W. T. Alexander. G. E.

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SCARBOROUGH, JOHN L., Associate Professor of Mechanical Engineering, Alabama Polytechnic Institute, Auburn, Alabama. 1959. Earl I. Brown, II, Gerald E. Tanger. M. E.; Mech. & Mat.

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Arthur D. Hughes, Wesley W. Smith. M. E.

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Clyde C. Whipple, Charles W. Lawrence. E. E.

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H. E Heath, W. Leighton Collins. Tech. Inst.; Shop & Mech. Arts.

BINDSCHEDLER, ANDRE, E., Research Assistant, Industrial Engineering Department, Purdue University, Lafayette, Indiana. 1959.
H. H. Young, Arthur V. Goughton. I. E.; Math.

BROOKS, CHARLIE R., Instructor in Chemical and Metallurgical Engineering, University of Tennessee, Knoxville, Tennessee. 1959.
John W. Prados, W. O. Harms. Min. Tech.; Ch. E.

BURNHAM, LYMAN, P., Instructor, Sacramento Junior College, Sacramento, California. 1959.
Bonham Campbell, Eugene Wood Smitte.

CARTER, HAROLD S., Professor, Westminster College, Salt Lake City, Utah. 1959.
Cleve H. Milligan, Dean F. Peterson. G. E.; C. E.

CHAMPY, EDWARD P., JR., Instructor in Mathematics and Physics, Lowell Technological Institute, Lowell, Massachusetts. 1959.
Richard Patrick Mayor, Albert T. Woldzik. Math.; Physics.

COX, CLAUDE W., JR., Section Chief-Instructor, Graduate Engineering Training Center, Western Electric Company, Inc., New York 19, New York. 1959.
Joseph N. Samek, Joseph E. Barry. E. E.

CURRAN, JOHN S., Instructor in Surveying, Dunwoody Institute, Minneapolis, Minnesota. 1959.
W. T. Alexander, W. Leighton Collins. C. E.; Math.

DEVORE, CHARLES, Vice President, Capitol Radio Engineering Institute, Washington 10, D. C. 1959.
Lattie M. Upchurch, James Paul Evans. Admin. Ed.; Nuclear E.

DRAKE, GEORGE M., JR., Instructor in Chemical and Metallurgical Engineering, The University of Tennessee, Knoxville, Tennessee. 1959.
John W. Prados, H. F. Johnson. Ch. E.; Chem.

DRAKE, MARGARET S., Instructor in Mechanical Engineering, University of Tennessee, Knoxville, Tennessee. 1959.
J. Mack Tucker, J. F. Bailey. M. E.

DRUGAN, FREDERICK T., Director, Relations with Schools, Ohio College of Applied Science, Cincinnati, Ohio. 1959.
Edward L. Fleckenstein, Kenneth Oleson. Tech. Inst.; Hum.-Soc.

DUVALL, M. GORDON, Head, Division of Chemical Technology, Ohio College of Applied Science, Cincinnati, Ohio. 1959.
Kenneth Oleson, Edward L. Fleckenstein. Chem.; Math.

DYKE, EUGENE L., Instructor, Sacramento Junior College, Sacramento, California. 1959.
Bonham Campbell, Eugene Wood Smith.

ELY, ROBERT F., Instructor in Electronics, Orange County Community College, Middletown, New York. 1959.
Herman W. Pollack, Hugh Halsey. Tech. Inst.; Elect. Tech.

FAHERTY, KEITH F., Instructor in Civil Engineering, Wisconsin Institute of Technology, Platteville, Wisconsin. 1959.
H. Gulbinowicz, A. T. Lenz. C. E.; Mech. & Mat.

FIRTH, CHARLES J., Instructor in Engineering Drawing, Villanova University, Villanova, Pennsylvania. 1959.
John B. Clothier, Jr., J. Stanley Morehouse. E. Graphics; E. E.

FLAVIN, WILLIAM M., Manager, Technical Employment, Carrier Corporation, Syracuse, New York. 1959.
J. F. Downie Smith, James H. Carpenter. Admin. Ind.; E. E.; M. E.

FOXWORTHY, JAMES E., Assistant Professor of Civil Engineering, Loyola University of Los Angeles, Los Angeles, California. 1959.
Daniel E. Whelan, Jr., Lawrence J. Wierzbicki. C. E.; Aero. E.

HEADLEY, LEWIS M., Editor, Wm. C. Brow Publishing Company, Los Angeles, California. 1959.
Homer H. Grant, Jr., William F. Girouard.

HULICK, LORING W., Instructor, Orange County Community College, Middletown, New York. 1959.
Herman W. Pollack, Hugh Halsey. Tech. Inst.; E. Graphics; Physics.

INGE, ANDREW V., Director, Department of Non-Resident Instr., U. S. Army Engineer School, Ft. Belvoir, Virginia. 1959.
J. D. Strong, Robert B. George. Admin. Ed.; G. E.

JENKINS, DONALD J., Manager, Personnel Training, Sandia Corporation, Sandia Base, Albuquerque, New Mexico. 1959.
W. G. Funk, R. K. Moore. Admin. Ind. Hum.-Soc.

JOHNSON, NAPOLEON, Professor and Head Civil Engineering, Tennessee Arts and I dustrial State University, Nashvil Tennessee. 1959.
James A. Parson, Jr., W. Leighton Collin C. E.

KLEMENT, FRANK W., Assistant Professor Engineering Graphics, University Florida, Gainesville, Florida. 1959.
E. W. Jacunski, J. F. Twigg. E. Graphic G. E.

KOMBRINK, RICHARD T., Instructor in Mecha cal Engineering, California Polytech College, San Luis Obispo, Californ 1959.
R. Wallace Reynolds, Chester O. Bish M. E.; E. Graphics.

LAFFERTY, JAMES F., Research Associate, U versity of Kentucky, Lexington, Kentuc 1959.
Hal W. Maynor, K. O. Lange. Aero.; N clear E.

LANDYSHEV, ALEXANDER N., Assistant Prof sor, California State Polytechnic Colle San Luis Obispo, California. 1959.
E. L. Fryberger, F. W. Bowden. E. E G. E.

LEE, WILLIAM M., Instructor in Mechani Engineering, University of Pittsburg Pittsburgh, Pennsylvania. 1959.
John R. Smith, T. G. Beckwith. M. E.

METZ, HENRY I., Vice-President in Charge Engineering, Capitol Radio Engineeri Institute, Washington, D. C. 1959.
Lattie M. Upchurch, James Paul Evan E. E.; Tech. Inst.

MIRALDI, FLORO D., Assistant Professor Electrical Engineering, Purdue Universit Lafayette, Indiana. 1959.
Arthur V. Houghton, Fritz J. Friedlaende Physics; E. E.

MCAULAY, HUBERT J., Director of Pre-En neering, Benedictine Heights Colle Tulsa, Oklahoma. 1959.
George B. Uicker, John J. Uicker. M. E Math.

MCCLURE, HOYT L., Head, Industrial Tec nology, Southern Technical Institu Chamblee, Georgia. 1959.
Robert W. Hays, George L. Carroll. I. E Admin. Ed.

NAKAMOTO, MAMORU, Professor, Yokohama U versity, Yokohama, Japan. 1959.
Issac Koga, Ken-ichi Iijima.

NOGES, ENDRIK, Assistant Professor of Elec cal Engineering, University of Washi ton, Seattle, Washington. 1959.
Austin V. Eastman, Lyall B. Cochra E. E.

PLATT, JOSEPH B., President, Harvey Mu College, Claremont, California. 1959.
Warren E. Wilson, William H. Davenpo Admin. Ed.; Physics.

PLUM, WILLIAM B., Head, Applied Scienc Department, U. S. Naval Civil Engineeri Laboratory, Port Hueneme, Californ 1959.
John C. Dillon, R. R. O'Neill. Admi Ind.; Math.; Physics.

POPE, THOMAS F., Instructor, Oakland C College, Oakland, California. 1959.
Bonham Campbell, James F. Schon.

RANEY, JOHN PHILIP, Instructor in Mechani Engineering, Purdue University, Lafayet Indiana. 1959.
James B. Lusk, F. J. Bogardus. M. E Agr. E.

REINHART, ALVIN R., Lecturer, Trinity Colle Hartford, Connecticut. 1959.
H. J. Lockwood, A. E. Sapega. E. Gra ics; Arch.

SALERNO, VITO L., Dean, School of Engineeri Science, Fairleigh Dickinson Universi Teaneck, New Jersey. 1959.
Clair W. Black, Chas. J. Merz, Jr. A min. Ed.; Physics.

SHANNON, PAUL T., Assistant Professor of Chemical Engineering, Purdue University, Lafayette, Indiana. 1959.
Edward C. Thoma, W. B. Sanders. Ch. E.

TUCKETT, HAROLD W., Co-ordinator, Engineering Technical Drawing, Flint Community Junior College, Flint, Michigan. 1959.
Clifton Matz, William Walworth. E. Graphics.

VALERIO, PAUL P., Instructor, Brooklyn Polytechnic Institute, Brooklyn, New York. 1959.
Charles W. Lawrence, Harold I. Sharlin. C. E.

VARSHNEY, BHADRA G., Training Officer, Technical Training Institute, S.F.C.P.L. Sindri Fertilizers and Chemicals (P) Ltd., Sindri (Dhanbad), Behar, India. 1959.
W. T. Alexander, W. Leighton Collins.

VROOMAN, SUMNER I., Chairman of Mathematics, Pratt Institute, Brooklyn, New York. 1959.
R. H. Cook, George C. Helme. Math.

WATTS, EARLE H., Assistant Professor of Engineering Graphics, University of Florida, Gainesville, Florida. 1959.
John F. Twigg, E. W. Jacunski. E. Graphics; Agr. E.; Arch.

WEAVER, DONALD K., JR., Associate Professor of Electrical Engineering, Montana State College, Bozeman, Montana. 1959.
W. O. Keightley, G. J. Herman. E. E.

WRAY, EDWARD M., Instructor in Civil Engineering, Ohio College of Applied Science, Cincinnati, Ohio. 1959.
David C. Choate, Kenneth Oleson. C. E.; E. Graphics; Tech. Inst.

ZAWORSKI, ROBERT J., Assistant Professor of Mechanical Engineering, Oregon State College, Corvallis, Oregon. 1959.
Wesley W. Smith, Louis Slegel. M. E.

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ALBRECHT, CARL F., Associate Professor of Agricultural Engineering, Michigan State University, East Lansing, Michigan. 1959.
James S. Boyd, Merle L. Esmry. Agr. E.

ANDERSON, LELAND I., Staff Engineer, Remington Rand Univac, Minneapolis, Minnesota. 1959.
Leonard F. Boon, Paul A. Cartwright. E. E.; Physics.

ANDERSON, PETER D., Assistant Professor of Mechanical Engineering, Kansas State University, Manhattan, Kansas. 1959.
A. O. Flinner, Ralph Nevins. M. E.; I. E.

ANDREWS, FRANK J., Registrar, Pennsylvania Technical Institute, Pittsburgh, Pennsylvania. 1959.
Louis A. Dimasi, E. L. Sulkowski. Tech. Inst.; Admin. Ed.

BALDWIN, JAMES W., JR., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Illinois. 1959.
Clyde E. Keslen, John W. Murdock. Mech. & Mat.; C. E.

BALLEW, OLIVER B., Head of Industrial Education Department, Navarro Junior College, Corsicana, Texas. 1959.
Amogene DeVaney, W. M. Whitley. E. Graphics; Shop & Mech. Arts.

BEHLKE, CHARLES E., Associate Professor of Civil Engineering, Oregon State College, Corvallis, Oregon. 1959.
A. D. Hughes, J. L. Gray. C. E.; E. Econ.

BLAKNEY, WILLIAM G., Assistant Professor of Civil Engineering, Alabama Polytechnic Institute, Auburn, Alabama. 1959.
Frank L. Holman, M. S. Priest. C. E.

BUNKER, FOREST R., Instructor in Engineering, Los Angeles City College, Los Angeles, California. 1959.
Bruce W. Martin, William R. Lennox. M. E.; E. Graphics.

CAUAS, JORGE L., Professor Auxiliar and Engineer, Escuela de Ingenieria, Universidad de Chile, Santiago, Chile. 1959.
W. L. Collins, E. d'Etigny. C. E.; E. Econ.

CHUN, MYUNG SOO, Instructor in Mathematics, Southern Technical Institute, Atlanta, Georgia. 1959.
C. V. Maddox, George L. Carroll. Tech. Inst.; Ch. E.

CUTLER, NEWEL B., Instructor in Engineering, Weber College, Ogden, Utah. 1959.
Jack Atkins, M. L. Stevenson.

DIEMER, WILLIAM D., Instructor, Illinois Institute of Technology, Chicago, Illinois. 1959.
H. C. Spencer, I. L. Hill. Mech. & Mat.; Arch. E.

DILL, ALLEN F., Director, Passive Defense Engineering, United States Naval School, Port Hueneme, California. 1959.
R. C. Jensen, T. C. Murphy.

DI TARANTO, ROCCO A., Associate Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pennsylvania. 1959.
J. Harland Billins, John B. Baker. M. E.; Mech. & Mat.

EPLEY, DONALD L., Instructor in Electrical Engineering, University of Illinois, Urbana, Illinois. 1959.
M. E. Van Valkenburg, G. R. Peirce. E. E.; Math.

EVANKO, JAMES L., Instructor in Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pennsylvania. 1959.
Thomas E. Stelson, Tung Au. C. E.

FENNINGER, WILLIAM N., Executive Secretary, American Technical Education Association, Delmar, New York. 1959.
W. L. Collins, W. T. Alexander. Tech. Inst.; Tech. Ed.

FRIEDLANDER, SHELDON K., Assistant Professor of Chemical Engineering, The Johns Hopkins University, Baltimore, Maryland. 1959.
H. E. Hoelscher, Eric Weger. Ch. E.

GAUS, MICHAEL P., Research Associate in Civil Engineering, University of Illinois, Urbana, Illinois. 1959.
W. J. Hall, J. E. Stallmeyer. C. E.; Mech. & Mat.

HARRIS, JAMES N., Instructor in Electronics, Tuskegee Institute, Tuskegee, Alabama. 1959.
Jefferson D. Davis, Jr., Ernest C. Levister, Jr. Tech. Inst.; Shop & Mech. Arts.

JONES, T. W., Associate Professor of Electrical Engineering, Tuskegee Institute, Tuskegee, Alabama. 1959.
Garland A. Smith, David H. Bowles. E. E.; Physics.

JUDD, HARL E., Instructor in Engineering, College of Southern Utah, Cedar City, Utah. 1959.
Elliot Rich, J. E. Christiansen. E. Graphics; Math.

KEATING, DONALD A., Instructor in Mechanical Engineering, University of Dayton, Dayton, Ohio. 1959.
Harold Nielsen, Thaddeus Csaky. M. E.; Physics.

KOP, PETER E., Instructor in Mechanical Technology, Wentworth Institute, Boston, Massachusetts. 1959.
Roger R. Borden, Patric H. Ferzoco. M. E.; E. Graphics.

KROGH, LLOYD W., Assistant to Director of Personnel Training, Cincinnati Milling Machine Company, Cincinnati, Ohio. 1959.
Thomas J. Rung, Herbert A. Daugel. Admin. Ind.

LAUCHNER, JULIAN H., Associate Professor of Ceramic Engineering, University of Illinois, Urbana, Illinois. 1959.
D. Opperman, John W. Hutchinson. Cer. E.; Ch. E.

LORD, PAUL A., Acting Assistant Professor of Aeronautical Engineering, University of Colorado, Boulder, Colorado. 1959.
K. D. Wood, C. L. Eckel. Aero. E.; Math.

LUTHER, LESTER C., Instructor in Mechanical Engineering, University of Nebraska, Lincoln, Nebraska. 1959.
Irvin L. Reis, Niles H. Barnard. I. E.; M. E.

MIKHAIL, SAAD Z., Associate Professor of Nuclear Engineering, Kansas State University, Manhattan, Kansas. 1959.
R. W. Clack, J. N. Wood. Physics; Chem.

MILLER, ROBERT E., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Illinois. 1959.
A. P. Boresi, T. M. Elsesser. Mech. & Mat.; Aero.

MOORE, EDWARD R., Manager of Engineering, The Detroit Edison Company, Detroit, Michigan. 1959.
Howard M. Hess, Donald L. Perkins. Admin. Ind.; G. E.

MUNSE, WILLIAM H., Professor of Civil Engineering, University of Illinois, Urbana, Illinois. 1959.
R. J. Mosborg, W. J. Hall. C. E.; Mech. & Mat.

MCEWEN, LAURANCE H., Manager, Programming, General Electric Company, Richland, Washington. 1959.
E. P. Galbraith, T. G. Marshall. Admin. Ind.; Ch. E.; E. Econ.

MCGARRIGLE, ROBERT D., Instructor in Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pennsylvania. 1959.
John B. Baker, C. Ralph Connell. M. E.; Math.

PHLEGER, CHARLES C., Assistant Professor of General Engineering, Rutgers University, New Brunswick, New Jersey. 1959.
Samuel P. Owen, Morgan C. Barrett. E. Graphics; Mech. & Mat.

POLLARA, LUIGI Z., Professor of Chemistry and Chemical Engineering, Stevens Institute of Technology, Hoboken, New Jersey. 1959.
Nicholas J. Rose, Mark R. Reeks. Chem.; Ch. E.

POWERS, JAMES E., Instructor in Electronic Engineering, Lowell Technological Institute, Lowell, Massachusetts. 1959.
F. B. Bischoff, B. C. Harcourt. E. E.; Physics.

RATHBUN, KENNETH C., Associate Professor of Mechanical Engineering, University of Texas, Austin, Texas. 1959.
John A. Focht, W. W. Dornberger. M. E.; Aero. & Aero E.

SALEEM, MUHAMMED I., Lecturer in Mechanical Engineering, College of Engineering, Lahore, Pakistan. 1959.
Robert M. Halleen, Jack T. Kimbrell. M. E.; E. Graphics.

SCHUSTER, JAMES J., Instructor in Civil Engineering, Villanova University, Villanova, Pennsylvania. 1959.
James E. Brown, Jr., John J. Gallen. C. E.; Mech. & Mat.

SCHUTZMAN, ELIAS, Assistant Director, New York University Graduate Center, New York, New York. 1959.
H. A. Giddings, J. H. Mulligan, Jr. Admin. Ed.; E. E.

SINNAMON, GEORGE K., Associate Professor of Civil Engineering, University of Illinois, Urbana, Illinois. 1959.
R. J. Mosborg, W. J. Austin. C. E.; Mech. & Mat.

SMITH, ALLEN N., Associate Professor of Chemical Engineering, San Jose State College, San Jose, California. 1959.
Philip M. Blair, Norman O. Gunderson. Ch. E.; Chem.

STRANCE, ROBERT J., Student in Technical Drawing, Illinois Institute of Technology, Chicago, Illinois. 1959.
I. L. Hill, J. T. Dygdon. E. Graphics; M. E.

TERRY, CHARLES F., Officer-in-Charge, United States Naval School, Electronics Officers, Great Lakes, Illinois. 1959.
Thomas J. Rung, Floyd B. Fischer. Admin. Ed.; Engl.

TURNER, NEAL W., Director of Product Planning, Heath Company, Benton Harbor, Michigan. 1959.
W. L. Collins, W. T. Alexander. Admin. Ind.

UGOLETTI, LOUIS S., Assistant Academic Director, Pennsylvania Technical Institute, Pittsburgh, Pennsylvania. 1959.
Louis A. Dimaji, Eugene L. Sulkowski. Physics; Math.

WARWARUK, JOSEPH, Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Illinois. 1959.
Clyde E. Kesler, John W. Murdock. Mech. & Mat.; C. E.

WILLIAMS, FRANK W., Dean, Engineering Technology, Sinclair College, Dayton, Ohio. 1959.
Donald C. Metz, Adrian J. Morgan. Admin. Ed.; Tech. Inst.

June 10, 1959

AMYX, JAMES W., Associate Professor of Petroleum, Agricultural and Mechanical College of Texas, College Station, Texas. 1959.
J. G. McGuire, W. E. Street. Min. Tech.

BEACH, ROBERT B., Instructor in Mechanical Engineering (Drawing), Virginia Military Institute, Lexington, Virginia. 1959.
Boyce D. Tate, A. C. Taylor, Jr. E. Graphics.

CALHOUN, DELMAR E., Instructor in Engineering, Fort Lewis A. & M. College, Durango, Colorado. 1959.
C. L. Eckel, Karl H. Stahl. C. E.; Mech. & Mat.

CAMPION, ANNA LOUISE, Librarian, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania. 1959.
K. A. Fegley, R. F. Schwartz. Libr.; E. E.

CHUBBUCK, EDWIN R., Associate Professor of Engineering Mechanics, Louisiana State University, Baton Rouge, Louisiana. 1959.
Dale R. Carver, T. A. Manning, Jr. Mech. & Mat.; Agr. E.

GRATCH, SERGE, Associate Professor of Mechanical Engineering, Northwestern University, Evanston, Illinois. 1959.
D. D. Kilner, A. B. Cambel. M. E.

HOWARD, WALTER W., Technical Consultant, Canadian Institute of Science and Technology, Toronto, Ontario. 1959.
W. E. Goddard, W. Leighton Collins. Ch. E.; Math.

MILLER, PERCY H. F., Assistant Professor of Aeronautical Engineering, The University of Texas, Austin, Texas. 1959.
M. J. Thompson, W. W. Hagerty. Aero. & Aero. E.; Admin. Ind.

MCLEOD, HERBERT E., Assistant Professor of Agricultural Engineering, Clemson College, Clemson, South Carolina. 1959.
A. W. Snell, John P. Uldrick. Agr. E.; Mech. & Mat.

PLACHY, FREDRIC R., Instructor, Fort Lewis A. & M. College, Durango, Colorado. 1959.
C. L. Eckel, Karl H. Stahl. Math.; Chem.

REED, CHARLES O., JR., Research Engineer, Shell Oil Company, Pasadena, Texas. 1959.
W. T. Alexander, W. Leighton Collins. Ch. E.; Math.

WALDNER, CHARLES E., General Methods Engineer, New York Telephone Company, New York, New York. 1959.
Matthew E. Zaret, Kenneth E. Lofgren. Admin. Ind.; E. E.

June 12, 1959

BEATY, HAROLD H., Professor of Agricultural Engineering, University of Illinois, Urbana, Illinois. 1959.
J. O. Curtis, E. L. Hansen.

BLOOM, FRANK J., Adjunct Professor of Electrical Engineering, New York University, New York 53, New York. 1959.
P. Greenstein, S. Shamis. E. E.; Admin. Ed.

MELOGRANO, FRANK P., Associate Professor, Adjunct, University of California, Los Angeles, California. 1959.
H. H. Grant, W. F. Girouard. I. E.; Admin. Ed.

MINTO, WILLIAM M., Assistant Works Engineer-Maintenance, Sheffield Division, Armco Steel Corp., Houston, Texas. 1959.
H. E. McCallick, A. Ray Sims. M. E.; E. E.

WEINSTEIN, ALEXANDER, Research Professor, Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park, Maryland. 1959.
F. T. Mavis, G. F. Corcoran. Math.

WOERNER, ROBERT N., Fiscal Officer, Engineering Schools, Purdue University, Lafayette, Indiana. 1959.
Kenneth Wark, Jr., John K. Stene.

YU, TSI SHAN, Assistant Professor of Chemical Engineering, University of Detroit, Detroit, Michigan. 1959.
H. G. Gudebski, C. G. Duncombe. Chem. E.

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July 22, 1959

ALBRIGHT, GIFFORD H., Assistant Professor of Architectural Engineering, Pennsylvania State University, University Park, Pennsylvania. 1959.
M. W. Isenberg, L. Perez. Arch. Eng.; Arch.

ALT, FRED, Chief—Instrument Section, National Institutes of Health, Bethesda, Maryland. 1959.
W. T. Alexander, W. L. Collins. Admin. Ind.; M. E.

ANDREWS, RAYNAL W., JR., Assistant Chief Mechanical Engineer, Aluminum Company of America, Pittsburgh, Pennsylvania. 1959.
M. A. Williamson, C. C. Chambers. M. E.

BALL, BILLIE J., Instructor in Electrical Engineering, Mississippi State University, State College, Mississippi. 1959.
D. F. Fitzgerald, J. E. Thomas. E. E.; Math.

BEATTY, KENNETH O., JR., Professor and Acting Head of Chemical Engineering, North Carolina State College, Raleigh, North Carolina. 1959.
E. M. Schoenborn, N. W. Conner. Ch. E.

BEGG, BARBARA A., Engineering Librarian, Drexel Institute of Technology, Philadelphia, Pennsylvania. 1959.
L. A. Brothers, D. Dowell. Libr.; G. E.

BROOKS, HENRY T., College Relations Administrator, Convair, A Division of General Dynamics Corporation, San Diego, California. 1959.
M. P. Capp, C. Morgan. Admin. Ind.

CARRINGTON, WINSTON H., Instructor in Industrial Education, Arizona State College, State College, Arizona. 1959.
J. R. Cudworth, R. W. Killingsworth. Mech. & Mat.; C. E.

CHOW, VEN TE, Professor of Hydraulic Engineering, University of Illinois, Urbana, Illinois. 1959.
E. Y. Huang, N. Khachaturian. C. E.

COLMEN, KENNETH S., Director of Personnel, Institute for Defense Analyses, Washington, D. C. 1959.
D. C. Metz, R. W. Cain. Admin. Ind.; Tech. Inst.

COMBS, CECIL E., Commandant, United States Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio. 1959.
R. H. Downing, G. R. Graetzer. Admin. Educ.; Hum.-Soc. Studies.

COOKE, ARTHUR J., Instructor in Mechanics, Wisconsin Institute of Technology, Platteville, Wisconsin. 1959.
R. R. Benedict, T. J. Higgins. Mech. & Mat.; E. E.

COOPER, WILLIS M., Assistant General Manager of Research and Engineering, Monsanto Chemical Company, St. Louis, Missouri. 1959.
J. O. Hougen, R. F. McCoole. Admin. Ind.; Ch. E.

ELGOOD, WILLIAM R., Head of Library Development, General Motors Institute, Flint, Michigan. 1959.
H. M. Dent, C. L. Tutt, Jr. Libr.

ERDLAC, RICHARD J., Associate Professor of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pennsylvania. 1959.
W. R. Turkes, N. L. Buck. M. E.; Mech. & Mat.

ERPENBACH, JEROME J., Staff Training Officer, Tennessee Valley Authority, Chattanooga, Tennessee. 1959.
J. M. Henderson, A. B. Wood. Admin. Ind.; Coor. of Coop. Engr.

GHANDHI, BURZOE K., Research Engineer, Outboard Marine Research Center, Milwaukee, Wisconsin. 1959.
W. L. Collins, P. S. Myers. M. E.; Mech. & Mat.

GILES, GEORGE W., Head, Department of Agricultural Engineering, North Carolina State College, Raleigh, North Carolina. 1959.
R. G. Carson, Jr., N. W. Conner. Agr. E.

GLOMB, JOHN D., Research Fellow in Electrical Engineering, Microwave Research Institute, Polytechnic Institute of Brooklyn, Brooklyn, New York. 1959.
C. W. Lawrence, C. C. Whipple. E. E.

HABER, DONALD F., Instructor in Mechanics, Missouri School of Mines & Metallurgy, Rolla, Missouri. 1959.
R. F. Davidson, K. C. Muhlbauer. Mech. & Mat.; Geophy. E.

HACKNEY, JOHN W., Manager of Cost & Construction Engineering, Diamond Alkali Company, Cleveland, Ohio. 1959.
M. S. Peters, W. L. Collins. Admin. Ind.; C. E.

HAMILTON, ROBERT J., Assistant Professor of Engineering, Geneva College, Beaver Falls, Pennsylvania. 1959.
J. D. Dinker, W. F. Stokey. E. Graphics; C. E.

HARVEY, JOHN F., Director of Libraries, Dean, Library Science (Graduate Study), Drexel Institute of Technology, Philadelphia, Pennsylvania. 1959.
L. A. Brothers, D. Dowell. Libr.

HASSLER, FRANCIS J., Professor of Agricultural Engineering, North Carolina State College, Raleigh, North Carolina. 1959.
R. G. Carson, Jr., W. E. Adams. Agr. E.; Physics.

HEINSOHN, ROBERT J., Instructor in Mechanical Engineering, Michigan State University, East Lansing, Michigan. 1959.
C. Q. Ford, W. H. Loyd. M. E.; Aero & Aero. E.

HENDERSON, LOREN P., Specialist-Professional Recruitment, Hanford Laboratories, General Electric, Richland, Washington. 1959.
T. G. Marshall, E. P. Galbraith.

HULLEY, CLAIR M., Assistant Professor of Engineering Graphics, University of Cincinnati, Cincinnati, Ohio. 1959.
H. K. Justice, J. H. Sarver. E. Graphics; M. E.

JACOBSON, ALBERT H., JR., Associate Dean of Engineering and Architecture, The Pennsylvania State University, University Park, Pennsylvania. 1959.
E. B. Stavely, M. A. Williamson. Admin. Ed.; I. E.; Physics.

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J. Gammell, C. Rawles. Agr. E.; Math.

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C. H. Bensman, E. Notar. Tech. Inst.; Physics.

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G. M. Nordby, Q. Mees. C. E.

LIU, CHANG-KENG, Instructor in Mechanical Engineering, Indiana Technical College, Fort Wayne, Indiana. 1959.

I. A. Planck, R. R. Marshall. M. E.; Aero. & Aero. E.

LUCK, JULIUS O., Chairman of Physics Department, Fairleigh Dickinson University, Teaneck, New Jersey. 1959.
A. J. Monack, M. J. Bergen. Physics.

MARK, ALVIN O., Director, National Technical Schools, Los Angeles, California. 1959.
B. Campbell, H. W. Hartley. Tech. Inst.; Admin. Ind.

MARTINEZ, EUGENE P., Instructor in Mechanical Engineering, Lamar State College of Technology, Beaumont, Texas. 1959.
F. A. Thomas, Jr., R. L. Disney. M. E.

MELICK, GEORGE F., JR., Associate Professor of Mechanical Engineering, Columbia University, New York, New York. 1959.
R. H. Page, J. E. Englund. M. E.; G. E.

MILLER, DAVID, Associate Chemical Engineer, International Institute of Nuclear Science and Engineering, Argonne National Laboratory, Lemont, Illinois. 1959.
R. G. Taecker, B. T. Chao. Ch. E.; M. E.

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G. M. Goudey, E. J. Rainer. M. E.; E. Graphics.

NEELY, HENRY M., JR., Instructor in Mechanical Engineering, Kansas State University, Manhattan, Kansas. 1959.
R. G. Nevins, J. N. Wood. M. E.; E. Graphics.

NEWMAN, KENNETH A., Supervisor General Personnel Activities, Michigan Bell Telephone Company, Detroit, Michigan. 1959.
H. E. Heath, W. L. Collins. Admin. Ind.; Coor. of Coop. Engr.

RAND, WALTER, Assistant Professor of Civil Engineering, The City College of New York, New York, New York. 1959.
P. Hartman, J. R. Steven. C. E.; Hum.-Soc. Studies; Mech. & Mat.

ROBERTSON, BENNETT E., Professor of Physi
United States Air Force Academy, C
orado. 1959.
L. R. Standifer, A. Higdon. Physics.

RYDER, FRANCIS C., College Relations Sup
visor, Sylvania Electronic Systems, W
tham, Massachusetts. 1959.
F. L. Foster, K. L. Wildes. Admin. In
Coor. of Coop. Engr.

SCHILLING, CHARLES H., Professor of Milita
Art and Engineering, United States Mi
tary Academy, West Point, New Yo
1959.
L. E. Schick, B. W. Bartlett. C.
Mech. & Mat.

SHONKA, WILLIAM J., Chairman of Physi
St. Procopius College, Lisle, Illinois. 19
H. E. Heath, W. L. Collins. Physic
Math.

STEPHENS, RALPH I., Instructor in Theoreti
and Applied Mechanics, University of I
nois, Urbana, Illinois. 1959.
O. M. Sidebottom, J. W. Baldwin,
Mech. & Mat.; E. Graphics.

SUAREZ-BETANCOURT, JESUS M., Instructor
Civil Engineering, University of Pue
Rico, Mayaguez, Puerto Rico. 1959.
A. Golderos, H. M. Marini. C. E.; G.

TIMMERHAUS, KLAUS D., Associate Profes
of Chemical Engineering, University
Colorado, Boulder, Colorado. 1959.
R. E. West, B. E. Lauer. Ch. E.; M.

TWOMBLY, HURD W., Instructor in Engineeri
Foothill Junior College, Mountain Vie
California. 1959.
J. H. Anderson, N. O. Gunderson.
Graphics; Mech. & Mat.

VIGLIELMO, JULES D., Training Coordinat
International Business Machines Corpo
tion, Kingston, New York. 1959.
R. O. Skatrud, J. Baird. Admin. In
Math.

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